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A ROENTGENOLOGIC STUDY OF METASTATIC MALIGNANCY OF THE BONES *

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PFAHLER, in his excellent paper presented before this Society in 1916, called attention to the characteristic roentgen appearance of metastatic carcinoma of the bone, and impressed on us the necessity of a thorough *x*-ray examination in all cases of known or suspected malignancy in which there is any suspicion of a secondary involvement in the osseous system. My object in this paper is further to emphasize this necessity and to give a summary of the combined clinical and roentgen findings in 65 such cases that have been seen in the Mayo Clinic.

Fraenkel, von Recklinghausen, and others, have described two types of secondary bone metastases, the osteoclastic and the osteoplastic. The osteoclastic form is characterized by marked lacunar absorption and destruction of bone causing an extreme porosis of the osseous tissue. The osteoplastic form is characterized also by lacunar absorption, but there is a marked thickening of the bone due to the collection of the malignant cells, and from a secondary calcification around the malignant process. According to these observers the two types occur simultaneously; this is substantiated by the roentgenologic evidence, the two being found quite frequently in the same bone.

The osteoclastic form is characterized in the roentgenogram by an extreme decrease in density, the bone having a honeycombed appearance that is typical.

The osteoplastic form is characterized in the roentgenogram by an irregular increase in bone density, the bones having a chalky appearance without cortical or periosteal thickening. Our observations agree with those of Pfahler, who states that the osteoplastic form is most common in cases of carcinoma of the prostate, while the osteoclastic is most common as a secondary manifestation of breast malignancy. Authorities on the subject differ as to the route of extension. Handley doubts the extension by the blood stream and believes that the malignant cells metastasize entirely by way of the lymphatics. Risley, from his own studies and a review of the literature, concludes that the metastasis occurs by either the blood or by the lymph stream.

The number of cases in our series in which there was no demonstrable involve-

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ment of either the deep or superficial lymph glands seems to show that the metastasis occurs quite frequently by way of the blood. Von Recklinghausen states that the bone is primarily involved in its marrow and that the cortex is involved through the foramen.

Mathews believes that the most common sources of bone metastasis are the breast, thyroid, prostate, and kidney. In the present series the primary growth was situated as follows:

	Cases
Breast	36
Prostate	11
Kidney	7
Thyroid	2
Vulva	1
Sigmoid	1
Uterus	1
Abdominal masses of unknown nature	3
Primary source not discovered	3

Carcinoma of the breast is unquestionably the most common primary source of bone metastasis, but if one considers the high percentage of carcinomas that are located in the breast, the height of this percentage will be materially reduced.

There seems to be a wide disparity between our statistics and those quoted in the literature in which carcinoma of the thyroid is regarded as being second only to carcinoma of the breast as a source of bone metastasis. As I have stated, we have in this series but two cases of bone metastasis originating in the thyroid gland, although we have seen several hundred malignant conditions of the thyroid, a high percentage of which were examined by the roentgen ray. This difference may be explained by Crotti's statement that malignant adenomas of the thyroid are very prone to give rise to bone metastasis, while they are very rare in cases of scirrhous cancer of the thyroid. The high percentage of metastases that are secondary to malignancy of the breast and prostate is probably due to the blood and lymph supply, and to the fact that the neoplasms are usually slow-growing types.

In all probability the extreme rareness of bone metastasis in cases of cancer of the stomach is due to the fact that malignant conditions of the stomach speedily produce death unless immediate treatment is given. In 1600 patients with cancer of the stomach who have been examined at the Mayo Clinic during the last ten years, no bone secondaries have been found. Of the 7 cases of bone metastasis secondary to tumors of the kidney, 6 followed hypernephromas, and one followed a so-called neurocytoma, a tumor originating in the sympathetic nerves in the adrenal. The case was that of a boy aged thirteen who had metastasis in the skull and sternum with a fatal termination within six months after the condition was discovered. In our experience the bony metastasis of all types of malignancy gives the same roentgen appearance, thus emphasizing the fallacy of attempting a cellular diagnosis by the roentgenogram. The metastases in the present series were as follows:

	Cases
Spine	22
Pelvis	11
Femur	9
Ribs	6
Humerus	6
Clavicle	1
Sternum	1
Radius	3
Skull	3
Tibia	2
Bones of hand	1

Risley states that metastases are rare below the elbow and knee, and explains this by the fact that death usually occurs before the process extends. However, in our series, there were 6 cases; 3 in the radius, 2 in the tibia, and 1 in the bones of the hand, in which there was extensive involvement.

As Pfahler has noted, the spine is the most common site of bone metastases, and any vertebra from the atlas to the sacrum

may be involved. In the 22 cases in our series showing spinal involvement more than one vertebra were involved in all and the process was located in the lumbar region in 75 per cent.

A review of the clinical histories of these cases shows that the average age of the patients was fifty years; 42 were females, and 23 were males; the average time that had elapsed since the primary growth was discovered was two and one-half years, the extremes being nine years in one case and six months in another. The most common symptom was pain, this being noted in 57 per cent of the cases. The pain is rather characteristic and resembles that of neuritis; it is almost always constant and is referred along the course of the nerve trunks. The pain is always increased by motion, but the degree of the increase is in direct proportion to the proximity of a joint to the area involved. It has been remarkable that in spite of extensive areas of involvement, the patient was able to move without apparent inconvenience: this is especially true in cases with metastases into the pelvic bones. While in cases of known or suspected malignancy the presence of pain should always be an indication for a thorough roentgen examination, it must be remembered that pain of a similar nature is a fairly common complaint of many patients over fifty years of age; this is particularly true in cases of extensive malignancy when pressure, either from the primary growth or enlarged glands secondary to it, may produce pain. It should also be borne in mind that malignant metastasis to the spinal cord is not uncommon, and that this produces pain similar to that caused by bone metastasis. Superficial swelling is uncommon in cases with bone metastasis, but in cases in which there is metastasis in the long bones or in the skull irregularities may be discovered by careful palpation. As Boggs says, spontaneous fracture is a fairly common occurrence in cases of bone metastasis and may be the first index of its presence. Spontaneous fractures occurred in 6 of our 65 cases, and in 2 there had been no previous indication of malignancy. One of the spontaneous fractures, located in the middle third of the humerus, united without delay. Our statistics seem to show that pulmonary and bone metastasis rarely occur together; in but 3 of our cases was there any evidence of involvement in the lungs.

As I have stated, the roentgen appearance of bone metastasis is quite characteristic, and in most cases an unqualified diagnosis may be made. Of course in this, as in all conditions, the roentgen evidence must be corroborated by careful clinical history-taking and examination. The cases presenting the most difficulty are those of suspected spinal involvement in which careful technic must be employed and satisfactory plates obtained before a diagnosis can be made. Lateral roentgenograms, as described by Hickey, have proved a great aid in the examination of these cases.

CONCLUSIONS

1. Bone metastases may result from malignancy of almost any organ, but the most common foci are the breast and prostate.

2. Bone metastases are uncommon in malignancy of the thyroid.

3. Bone and pulmonary metastases are rarely associated.

4. The most common symptom complained of is pain, which is fairly typical and should be regarded as an indication for a roentgen examination.

5. The roentgen appearance is characteristic, and a thorough examination should be made by the *x*-ray in all cases in which there is any suspicion of bone metastasis.

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DISCUSSION

Dr. Geo. E. Pfahler.—I have been very much interested in this subject and I appreciate the further study that has been made by Dr. Moore. There is one point on which I probably would not agree with him, and that is the rarity of lung involvement in connection with the involvement of the bones. I have not looked up the statistics, but I have just run through this subject, and I will present the lung side a little later; but I am sure that at least ten per cent of the cases I studied had bone involvement. We would probably find a great deal more of bone involvement if we studied these cases more and studied the bones thoroughly. We are apt to confine our studies of bones to cases that complain of pain. Generally speaking that has been my practice, because it is quite a job to go over the bones of the entire body unless you are paid for it.

I would also like to emphasize what he has said, that very frequently or generally the patients die of the disease before it has reached the bones; and if we could keep the patient alive longer, we would be apt to get more bone involvement, which probably accounts for the fact that I found a larger percentage. In other words, I treated these cases and kept them from local recurrences, and that is the reason I find these bone involvements.

The second point I would like to emphasize is the great tendency to involvement of the lumbar spine and the iliac bones in the neighborhood of the sacro-iliac joint, accounting for these sciatic pains, as the patients describe them. They all complain of sciatica or of rheumatism of the hip, and we generally find an involvement of the upper portion of the ilium at the upper extremity of the sacro-iliac joint. I think also that we find the more frequent association of this with breast cases because we have more breast cases to deal with.

Dr. William H. Stewart.—I am especially interested in Doctor Moore's subject, believing that bone metastases take on much the same histological changes as the primary growth, i.e., where the original tumor was a soft medullary growth the bone metastasis appears as the osteoclastic form, while, if the primary cancer was scirrhous, the secondary bone manifestations would be of the osteoplastic form. This is a rather broad statement but so strongly do I feel the correctness of this observation that I frequently venture to diagnose the character of the primary growth by the appearance of the secondary manifestations. Especially does this apply to the osteoplastic form following carcinoma of the prostate and the osteoclastic form following carcinoma of the breast.

I trust Doctor Moore will support me in these observations.

Dr. L. T. LeWald.—I understood Dr. Moore to say that it was futile to attempt to distinguish the type of primary growth by the type of secondary growth, and that has been my experience—that the secondary growths from different types of tumors may look alike. I have seen a number of instances of that sort. I showed some of these last year at the meeting, and exception was taken on the ground that they were unusual cases; but I think Dr. Moore's series would back up that statement, that it is futile to attempt to distinguish the histological type of tumor by its gross manifestations in the bone.

Dr. David R. Bowen.—I would like to ask Dr. Moore whether he finds relationship between the metastases and the area involved—whether malignancy of the prostate is likely to involve the adjacent skeleton, as the lower ilium, rather than the more remote bony structures.

Dr. C. F. Ball.—I would like to ask Dr. Moore whether the age at which metastasis occurs indicates anything as to severity of bony lesion as does age to the appearance of the primary lesion. I had a patient thirty-two years of age in whom the amount of pain she complained of following her breast amputation and postoperative *x*-ray irradiation was very slight. However, one day when coming to the office

for treatment for a nodule which had developed in her scar, she fell when attempting to step up from the street to the curb. Her fall was due to the head of the femur puncturing through the acetabulum as was later shown by *x*-ray examination. The whole ilium and the shaft of the femur were simply honeycombed, the principal process being not near the sacrum but around the acetabulum. She was not complaining of pain that required any definite attention or that required morphine. She had not complained of pain in the back or hip. This extensive process had developed with but few observed manifestations and these of so slight a nature as to have been practically overlooked until time of fracture. Beware of *suggestive* bone pains in malignant patients.

Dr. A. L. Gray.—In regard to what determines whether we have an osteoplastic or osteoclastic type of metastasis, it seems to me the thing that determines it is the type of the primary tumor and whether it is of rapid malignancy or is slow growing. I don't know whether Dr. Stewart means to confine the osteoplastic type to the prostate, but I am quite sure I have seen both kinds in the female and have usually attributed the difference to the type of primary tumor, whether it was of rapidly growing malignancy or whether it was one which allowed the bone sufficient time to repair in its imperfect way, producing osteosclerosis or hyperplasia of the bone.

Dr. A. B. Moore.—With regard to Dr. Pfahler's question about the intercurrence of metastases in the lungs and in the bones: I am not willing to disagree with him. I believe that Dr. Bissell stated that nothing lies like statistics. During the past three years I have been interested in metastasis in the lungs, and in a high percentage of these cases I have tried to make an examination of the long bones. Many of these patients are, however, too sick to be submitted to examination, so that my findings are based only on partial statistics.

I am not able to answer Dr. Hickey's question as to whether or not any idea of the type of the primary growth may be gained from the type of bone metastasis.

I emphatically agree with Dr. Stewart that a case of osteoplastic metastasis may rightly be called "secondary to the prostate" in the majority of cases. Whether there is a reason for this I do not know. Certainly osteoplastic metastasis is not always due to carcinoma of the prostate, nor is it the only type which may be associated with carcinoma of the prostate. However, it is the most frequent type that I have seen. In cases of carcinoma of the breast I have observed osteoplastic and osteoclastic types of metastasis in the same bone. When the bone is sectioned by the pathologist honeycombing is found, and in areas in which the process is localized there is a secondary thickening and calcification. Osteoplastic metastasis might be expected to be a type associated with slow growing conditions in which the patient has a certain immunity, but this is merely speculation.

In regard to Dr. Bissell's question as to the site of the primary lesion: In the osteoplastic type the prostate may always be suspected, and in young persons the tumors around the kidneys are the most common site for the metastases. In fact, in children with irregularities of the skull, and emaciation, the first thing to be suspected is kidney tumor.

I agree with Dr. Boggs' statement that scirrhous carcinoma of the breast is the most common type of breast cancer which produces bone metastases. A certain type of case that we all see, is that in which the blood picture indicates a pernicious anemia, but the other findings are not typical of the condition. Harrington states that these patients are very often suffering from a malignant condition with bone metastases.

MYXOMA OF BONE WITH REPORT OF A CASE OF MYXOCHONDRO-SARCOMA OF THE FEMUR *

BY ALBERTUS COTTON, M.D. AND STANDISH McCLEARY, M.D.

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AT the New York meeting of the American Roentgen Ray Society in September, 1917, in collaboration with Dr. Standish McCleary, I reported a case of myxoma of the femur. This report appeared later in Vol. V, No. 2 and No. 4 of the JOURNAL. On account of the great destruction of the limb in this case it was necessary to amputate at the hip joint. After careful examination of the entire amputated femur and thigh, the report of the pathologist was pure myxoma. This patient lived comfortably for a period of two years, during which time she gained flesh and enjoyed good health. She had some pain in the stump of the amputated limb during this time but not sufficient to require anodynes. A little more than two years after the operation, the patient developed a mass in the lower abdomen just above the groin on the right side, which caused her severe pain in the lower abdomen and stump of the amputated limb. At about the same time the patient developed a cough which persisted to the time of her death. There was no hemorrhage from the lungs and the patient did not have dyspnea. There was a gradual loss of strength and flesh until the patient died in April, 1919, two and a half years after amputation. The tumor mass did not break down or ulcerate and no section was obtained for pathological examination. The report sent would indicate that the patient died from a recurrent sarcoma.

I now wish to report another case of medullary tumor of the femur which was diagnosed by gross and microscopic examination made at the time of the exploratory operation as myxochondroma. A conservative operation was done consisting of chiseling and curetting the affected area of the femur. The patient recovered from this operation and was able to attend to his business when a recurrence was noted. Amputation at the hip joint was done. Examination of the amputated specimen showed the tumor to be a myxochondrosarcoma of the femur. The patient now has metastasis in the lungs and a recurrence in the stump.

The following is the report of this case: C. W., aged forty-five, reported for examination and treatment in May, 1918.

Family History.—Negative.

Previous History.—Patient had injury to left shoulder and hip five years previously. No immediate after-effects were noted from this injury.

History of the Present Condition.—Two years previously the patient began to have pain in lower back, left buttock and thigh. During the past year the pain had been worse in the thigh. The patient had consulted a dozen or more physicians and was treated for rheumatism, neuritis and various other conditions without relief.

Physical Examination.—There were no physical signs of sacro-iliac trouble. The hip joint movements were normal on both sides. Some tenderness was noted over the upper three-fourths of the shaft of the left femur. There was no muscle atrophy, no tumor showing, and no difference in measurements of limbs at this time. The general condition of the patient was good.

X-ray Examination.—Plates were made of the lower lumbar spine, pelvis, right and left hips and femurs. The lumbar spine, pelvis and right hip and femur plates were negative. The plate of the left hip-joint and upper third of the femur showed an enlargement of the shaft of the femur from just below the great trochanter

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to the middle of the shaft. The enlargement was produced by the bulging outward of the cortical bone. There was irregularity of outline of the cortex throughout this area and thinning at the upper part just below the trochanter major. The rest of the cortex in this area was of normal thickness. No periosteal bone formation was shown from the cortex or in the muscles. The plate made five months after the first operation showed practically the same conditions except that there was thinning of the cortex with pointed bulging where the tumor had eroded the bone. The plate made immediately before amputation (seven months after the first operation) showed more bone destruction with periosteal new bone formation along the inner surface of the shaft extending into the muscles.

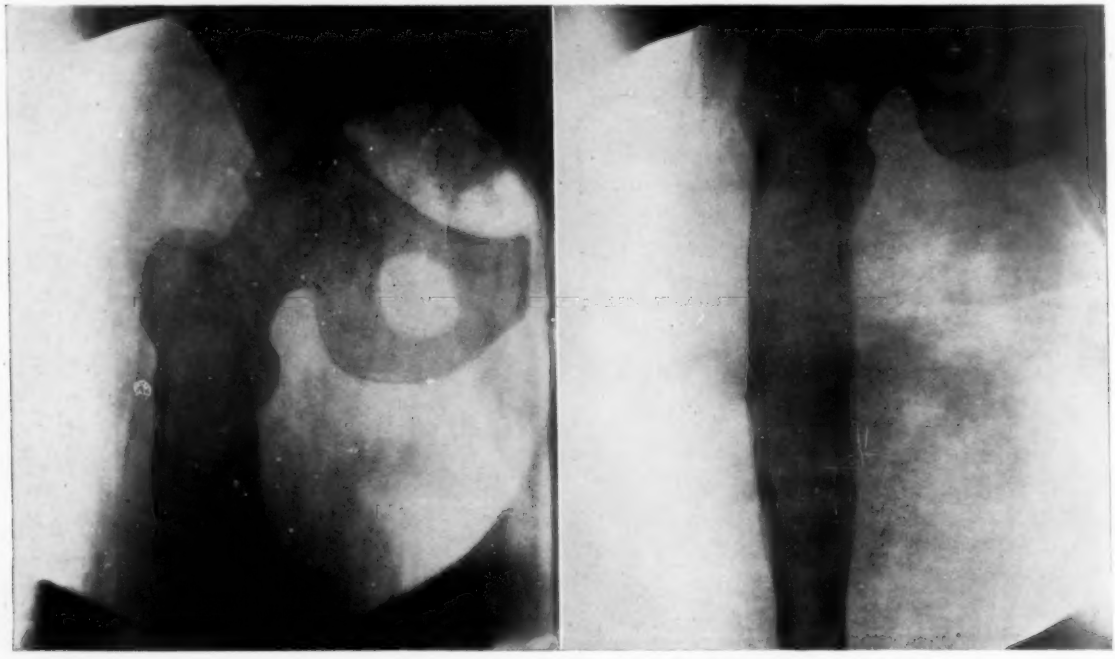
FIGS. 1 AND 2. LEFT FEMUR, HIP AND THIGH ONE MONTH BEFORE OPERATION.

Report of the Blood Examination.—Wassermann negative; white cell count 8,700 with 55 per cent polys., 33 per cent lymphocytes, 3 per cent large monos., 2 per cent eosinophiles, 6 per cent basophiles.

A diagnosis of medullary tumor of the femur was made, and the patient was taken to the hospital for operation several weeks after being first seen. At this time there was a tumor about the size of an orange over the anterior lateral surface of the upper third of the thigh. A long incision was made over the site of the tumor, which was found to be a bulging upward of the crureus muscle from the shaft of the bone and cystic in character. On cutting into the tumor it was found to contain gelatinous material characteristic of a myxomatous tumor. There was no blood in the cyst and grossly it did not look like sarcoma. From the gross examination both Dr. McCleary and I made a diagnosis of myxoma. The femur was exposed throughout the entire area of enlargement. A sinus was found leading into the medullary cavity of the bone, and the cortex of the bone was enlarged from the greater tuberosity to the middle of the femur. There were no osteophites present or bony growths in the muscle. The outer surface of the femur was smooth and normal in appearance except for the enlargement. With the chisel and curette, the entire

affected area of bone was removed leaving only a posterior shell of the shaft. The bone was packed with gauze and the soft parts partially closed. The patient had a satisfactory convalescence and the wound entirely healed in about four months. At this time the patient had no pain and seemed to be entirely well and was able to resume his occupation. Within two months after the healing of the operative wound, the patient noticed a swelling of the thigh at the site of the previous operation, which increased rapidly. There was no pain at this time. A diagnosis of recurrence of the tumor was made and the patient advised to have amputation at the hip joint. Disarticulation was done in December, 1918. Microscopic examination of the amputated specimen by Dr. Standish McCleary showed myxochondrosarcoma. Dr. McCleary's report is as follows:

Original Examination.—The material examined was of a gelatinous consistency and sections made from numerous blocks of tissue showed the same structure. Microscopically there were seen cartilage cells of various sizes, irregularly grouped, lying in a stroma which was distinctly myxomatous both in its structure and its reaction to stains. A few blood vessels had grown into the tissue. At some places new cartilage was seen developing and there were a few minute areas of calcification. Not the slightest suggestion of sarcoma was apparent in any of the numerous sections. The impression was that we were dealing with a chondroma which was undergoing a myxomatous change and in places forming actual cysts.



FIGS. 3 AND 4. FIVE MONTHS AFTER FIRST OPERATION.

Tissue from the Amputated Limb.—Sections from the medullary cavity showed that the cartilage cells were less numerous and the matrix was invaded by masses of cells chiefly, round which showed various nuclear abnormalities and every evidence of rapid proliferation. There were areas in which the myxomatous substance still remained, but the striking feature was the great preponderance of the sarcomatous elements. Beneath the periosteum the proliferated cells were chiefly spindle.

The points of most interest in this case are, first, what was the nature of the original growth, and second, was the tumor malignant from the beginning or was it a benign tumor in which a malignant process subsequently occurred? I am inclined to the opinion that we were dealing with multiple chondromata in which a myxomatous change was developed, forming the gelatinous cyst-like masses, and that subsequently a sarcomatous change developed in the cells of certain areas of the original tumor which were not removed. It is possible but unlikely that there were malignant areas from the beginning which escaped detection. The question of the transformation of a benign into a malignant tumor has long been an oncological battle-ground. We are of those who believe that such a change is possible but infrequent, as is so well illustrated by the pigmented moles. Most of these are benign throughout the life of the host, yet no one will deny that they may become frightfully malignant.

The patient did well after the operation and the wound healed in two months. Again the patient resumed work apparently all right. About March 1, 1919, the patient noticed a painless swelling in the groin, which increased to the size of a large orange. *X*-ray treatment was given at that time, a hard ray being used through a 3 mm. aluminum filter. Sufficient dosage was given to produce marked erythema. The *X*-ray had no effect upon the tumor. On April 24, 1919, the tumor was excised. It was found to consist of the same myxomatous tissue found in the femur. The operative wound healed by granulation in about six weeks. About the time this wound healed the patient developed a cough followed by a hemorrhage from the lungs. This cough began in March, and the first hemorrhage occurred in May, 1919. The patient had a second hemorrhage in July. At that time *x*-ray examination of the chest was made and characteristic metastases were shown in the right lung.

About the middle of June, a hard swelling appeared in the center of the amputated stump. An incision was made over

FIG. 5. IMMEDIATELY BEFORE OPERATION.

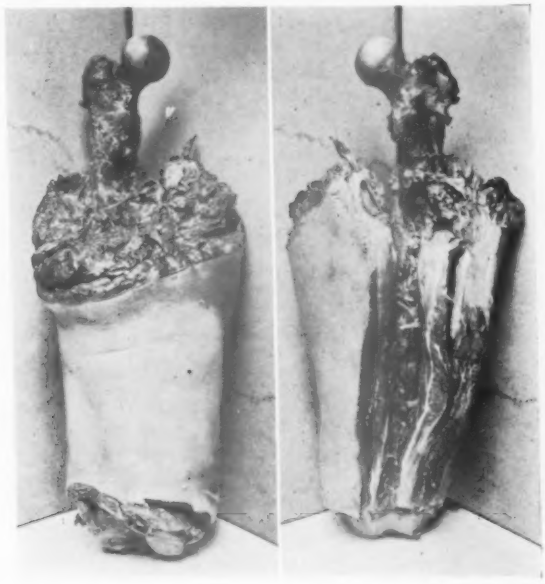


FIG. 6. SPECIMEN OF AMPUTATED FEMUR.

the swelling under local anesthesia. A mass of blood clots were removed followed by free bleeding. The bleeding was so free, in fact, that the patient had marked constitutional symptoms and it was necessary to pack the wound very tightly and to give constitutional treatment for hemorrhage. The patient rallied and since that time the cavity of the recurrent tumor of the stump has been treated by cleansing and packing. This area has the characteristic appearance of sarcomatous tissue, bleeds easily and is attended by a marked odor of putrefaction due to necrosis of tissue. The patient's general health is gradually failing. He suffers considerably from dyspnœa and periodical coughing spells. He now has recurrent sarcoma of the stump and metastases in the lungs.

FIG. 7. METASTASES IN RIGHT LUNG.

In comparing the clinical history of these two cases of myxoma of the femur we note in the early stages the following points of resemblance: slow onset; obscure symptoms; predominating symptom, pain resembling sciatica; difficulty in making a diagnosis; later great destruction of bone with enlargement of the thigh and loss of function of the limb; finally, recurrence with malignancy in both cases.

Comparison of the points of resemblance in the *x*-ray examination of these two cases shows that both originated in the medullary cavity; that both were attended by enlargement of the medullary cavity and expansion of the cortex; that later on there was breaking through the cortex and periosteum and extension of the tumor into the muscles; that there were cystic areas in the soft tissues due to the tumor mass pushing out the muscles, and that there was irregularity in outline of the cortex.

The following points of difference were noted: The *x*-ray examination of the second case was made at an earlier stage and before exploratory operation was done. In the second case there was less thinning of the cortex and periosteal bone formation. The tumor extended from the great trochanter only to the middle of the shaft of the femur. Below the middle the femur was normal in appearance. There was no new bone formation in the muscles where the cystic areas were found.

Comparison of the pathological reports.—Dr. McCleary's pathological report in the case of Mrs. D. (the first case) showed pure myxomatous tissue with evidence of processes of repair and of bone absorption. The pathological report of the second case, C. W., showed, first, myxochondroma. The second report made after amputation showed myxochondro-sarcoma.

These two cases have given us a rare opportunity for studying myxoma of bone. Very few cases have been reported. A detailed search of the literature two years ago failed to reveal any cases of pure myxoma of bone reported. Several cases of myxochondroma and myxo-sarcoma were found. Whether or not myxoma as a tumor should be considered an entity has been a mooted question among surgical pathologists. Fisher, in the June number of the *Annals of Surgery*, reports a case of pure myxoma of the labium majus. In this

article he has summarized the views of a number of pathologists. He quotes Adami as follows: "Many pathologists doubt whether we ought to regard the myxoma as a separate form of tumor, and urge that we should speak rather of myxomatous modification or degeneration of some one or other form of connective-tissue neoplasm—of lipoma, chondroma or fibroma myxomatodes, rather than of myxolipoma, etc. As such the majority of so-called myxomas must be regarded. But Ribbert has described small pure myxomatous tumors of the endocardium. Further, cases have been recorded as congenital myxoma, the tumors being recognized at the time of birth."

Bland Sutton states: "It would be convenient and perfectly justifiable to deprive myxomata of even the rank of species among tumors."

Mallory says it is "a comparatively rare tumor and therefore clinically of minor importance. It is questionable whether it deserves recognition as an entity. A true primary myxoma which has its origin from embryonal mucous tissue is rare." He also says that "secondary myxomas may develop by degeneration of mesoblastic tumors, such as occur in fibroma, lipoma, and chondroma."

Ribbert maintains the independence of the myxoma as a distinct tumor which may be combined with cartilage or with bone, etc., to form a myxochondroma or myxo-osteoma.

Bloodgood says: "Pure myxomas are rare bone tumors. I have observed one exhibiting itself as an exostosis of the shaft of the humerus; I have seen it combined with cartilage as a multiple lesion arising from the rib, and as a periosteal growth from the os calcis."

Fisher states in the report of his case: "I am convinced that pure myxoma should be classified as an entity."

It is evident from the quotations cited that pathologists do not agree on this subject. Some regard the condition as purely a degeneration of some other form of tumor, either benign or malignant. Others recognize it as a benign tumor which may remain benign or become malignant. From the history of these two cases, whether we consider myxoma a primary tumor or a secondary degeneration of a pre-existing tumor, there is a marked tendency to malignant degeneration.

Dr. Coley has called attention to the unreliability of the frozen section in the diagnosis of tumors while you wait at the operating table. The benign portion only may be present in the specimen and the malignant portion missed. For this reason it is much better to form a judgment from the gross appearance at the exploratory operation than to depend upon the frozen microscopic sections.

The practical points to be considered by the surgeon are: (1) Are these tumors primarily chondrosarcomata which have undergone myxomatous degeneration? (2) If primarily myxomata or myxochondromata, what per cent undergo malignant degeneration and become sarcomatous? (3) Are we justified in treating these tumors by conservative operations?

Diagnosis of myxomatous tumors of bone must be made by careful study of the clinical history, signs and symptoms, *x*-ray plates and by the exploratory incision. It is questionable whether or not a diagnosis can be made from the clinical history signs and symptoms and the *x*-ray examination. The *x*-ray plates tell us that we are dealing with a medullary tumor of bone, but whether it is myxoma, bone cyst or ostitis fibrosa is a difficult question to determine. Diagnosis must finally be made from the exploratory incision and the examination of the gross tumor. Frozen microscopic sections cannot be depended upon.

The question of the treatment of these tumors is a most important one for the patient. The question of conservative treatment is applicable only to early cases. Late cases require amputation at the hip joint to relieve a painful, functionless limb. Conservative operation means a more or less extensive operation, the object of

which is to remove all tumor tissue by the chisel and curette or by cautery and to retain the function of the thigh. The treatment by the chisel and curette would be similar to the operative treatment for giant cell sarcoma. Radical treatment means amputation at the hip joint with the loss of one-fourth of the patient's body. If, following an exploratory operation, the pathologist reports a benign tumor, the surgeon is naturally inclined to conservative treatment. If a similar report is received from a careful study of the amputated femur of advanced cases, the surgeon is inclined to believe that he has cured his patient. The history of these two cases that have come under our observation would seem to teach us that conservative treatment is never indicated and that we cannot assure our patient that recurrence will not take place, either *in loco* or by metastasis. It is practically impossible to remove all tumor tissue by the chisel and curette, which fact makes a recurrence *in loco* probable. Whether these tumors are primarily sarcoma or primarily chondroma or myxoma with later sarcomatous degeneration, they ultimately become sarcomatous in a large proportion of cases, especially in cases of recurrence after conservative operative procedures.

With these facts before us there can be very little room for argument as to treatment. The proper treatment of these cases is radical—that is, amputation well above the tumor as soon as a diagnosis is made. In case the tumor is located in the middle or upper third of the femur, amputation at the hip joint should be done. The patient should be prepared for hip-joint amputation at the same time the exploratory incision is made into the tumor for diagnosis. If the tumor shows the *gross* appearance of myxoma, myxo-chondroma or myxochondro-sarcoma, the exploratory field should be isolated, and with fresh instruments, gloves, etc., disarticulation of the hip-joint should be done at once. It may be argued that if the tumor is already sarcomatous amputation will not cure the patient, and such a mutilating operation as hip-joint amputation is not justifiable. In answer it may be said that conservative treatment, including the chiseling and curetting operation, offers no chance of a cure or more than a temporary relief of the symptoms. On the other hand, early amputation well above the tumor even in sarcoma will relieve the patient of a very painful condition and prolong life. In cases in which the tumor has the gross and microscopic characteristics of myxoma or myxochondroma only, early amputation should cure the patient. To be successful, the operation must be done early and well above the tumor tissue.

[NOTE: The patient whose case is reported above died Sept. 20, 1919. A piece of tissue from the ulcerated stump of the amputated limb was obtained. The following is Dr. McCleary's report of the examination of this tissue:

The tissue consists almost exclusively of spindle cells, many of which show marked abnormalities in nuclear structure. Among the spindle cells are a number of minute islands of hyaline cartilage about a millimeter in diameter. The presence of this cartilage in the recurrence in a soft part is most interesting and may be considered as a confirmation of our theory that the original tumor was a chondroma which subsequently became a sarcoma. The presence of the cartilage among the sarcomatous tissue is easily accounted for by some of the cells composing the sarcoma reverting to the type of connective tissue from which they originally developed.]

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DISLOCATION OF THE INNOMINATE BONE *

BY JOHN T. MURPHY, M.D.

TOLEDO, OHIO

MY object in presenting this subject is to call attention to either a very rare condition or one that has been much neglected in medical literature. In this paper it is my aim to discuss only the distinctly traumatic type, cases in which the injury was severe and the pathology definite. In this manner I hope to avoid a promising but not very satisfying study of the less pronounced sacro-iliac pathology with which we are all familiar.

The condition is defined as a separation of the innominate bone from its attachments and its displacement upward and backward, the dislocation occurring without fracture of the bone. The condition is not of much importance from a clinical viewpoint, because it is so rare; but it is from the small number of reported cases that an added interest arises. This applies especially to the roentgenologist, as it is upon him that the diagnosis depends.

The pathology is a tearing of the anterior, posterior and the interosseous ligaments of the sacro-iliac joint and of the symphysis pubes. In the most severe cases even the sacro-sciatic ligaments may be ruptured. The diagnosis with the aid of the radiogram is easy; the inequality of the two sides is very evident. A stereoscopic set of plates is an aid, as they show the posterior displacement. Clinically there may be but little difference in the appearance of the two sides. Measurement if made in the usual manner, from the anterior superior spine of the ilium to the inner malleolus of the tibia, will show both sides to be of equal length; if, however, the measurement is made from the umbilicus or better still from some fixed point higher up, a difference will be found that will correspond to the upward displacement of the bone. Changes in appearance when present and the difference in the measurements may also be found in vertical fractures of the sacrum.

Treatment of the latter condition might be very similar to that of a dislocation, but the prognosis might be very dissimilar, due to the nerves enclosed in the sacral canal. In determining the prognosis the separation of the bones is not of much importance. It is the injury to the soft parts that we must consider, rupture of the bladder, of the pelvic colon or of the rectum; and injuries to the large blood vessels and nerves are the causes of immediate death or subsequent troubles. The shock of so severe an injury is always an important factor and must be considered in all cases. As a general statement of the reported cases, those who survived the original shock recovered.

The treatment is reduction, when possible, and fixation as in fractures of the pelvis. Complete reduction was accomplished in only two of twelve reported cases, one case was partially reduced, one case reduced itself, and in five cases no reduction was possible.

A careful review of the world's literature made by Simpson in 1918 revealed only fifteen authentic cases, two of these being complicated by small fractures. To this he added a case of his own, and as the history is typical of most of the reported cases I will quote it.

A man fifty years of age, while on his hands and knees at the bottom of an elevator shaft, was struck on his back when the elevator descended. The shock was very severe; the left thigh was flexed on the pelvis, the leg on the thigh. The leg was abducted and rotated inward. *X*-rays showed a wide separation of both the sacro-iliac and the symphysis pubes. The result is given as recovery in ten months without shortening or loss of function.

*Read before the Twentieth Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Saratoga Springs, N. Y., September 3–6, 1919.

The history of the case I wish to report is as follows: boy aged six years fell from the seat of a farm wagon loaded with 3,200 pounds of coal, and the front wheels passed over his abdomen. Shock and prostration were marked. Patient could not be moved for ten days, when he was brought in for examination, the result of which was as follows: Well nourished boy, not in pain and apparently in good condition. Leg flexed and foot everted. Large hematoma covered the entire lumbar region. *X*-rays revealed the condition as shown in the slide. Attempted reduction failed; fixation in plaster for three weeks, recovered, function normal.

FIG. 1. DISLOCATION OF INNOMINATE BONE AS RESULT OF SEVERE INJURY.

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DISCUSSION

DR. G. C. JOHNSTON.—I believe those cases are not so scarce as they are supposed to be. They are not reported. In Pittsburgh we have accidents due to mine crushes and these injuries occur with excessive traumatism, and I know I have seen three such cases, not of dislocation alone but of dislocation accompanied by other injuries. In each case there was a great amount of force, either due to a fall of slate (several tons), or crushing between mine cars.

ARITHMETICAL COMPUTATION OF ROENTGEN DOSAGE*†

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The so-called indirect or electrical method of estimating the roentgen dose antedates all other schemes of measurement in practical work. Before the advent of the interrupterless transformer and the Coolidge tube, this method was unreliable and gave way to the so-called direct technic, where pastils or photographic paper instead of spark gap, milliamperage, time and distance were employed. Today, however, with modern apparatus and indirect technic, it is possible to duplicate results at will.

The technic outlined in this article is

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based on the invaluable work done by the eminent American physicist, Prof. J. S. Shearer,[1] of Cornell University, and experimental and practical work done in the author's laboratory by the latter's associate, John Remer,[2] in collaboration with W. D. Witherbee of the Rockefeller Institute.

TECHNIC OF ELECTRICAL MEASUREMENT

In electrical measurement there are four essential factors, namely, milliamperage, voltage (spark gap), time and distance. These are the constants or factors that establish the technic. It is possible with modern apparatus to obtain and maintain these factors with an accuracy that fulfills practical requirements.

With 2 milliamperes of current, a 6 inch sharp or blunt pointed spark gap, a distance of 8 inches from anode to skin and an exposure of 3 minutes, a definite amount of rays will reach the skin. It is obvious that every time these factors are used and maintained throughout the exposure, the quantity of rays reaching the skin will be the same. It becomes feasible, therefore, to establish a technic that is sufficiently accurate for practical purposes, that will duplicate results and that can be passed from one operator to another.

It is advisable for the operator to know how much ray, in terms of units, is obtained with a given set of factors. This information can be ascertained in one of two ways: by biologic or radiometric standardization.

BIOLOGIC STANDARDIZATION

Let us adhere to the constants already given—Ma. 2, Sp. G. 6 in., T. 3 min., D. 8 in. Utilize a split-pea sized area of skin on the flexor surface of the forearm of a female adolescent (preferably a blond) for the experiment. Establish all the constants except time. Make an exposure of one minute and wait two weeks for a possible erythema. If none appears, expose a similar area for two minutes and so on. Assume that the third area exposed (three minutes) develops a faint but definite erythema—Ma. 2, Sp. G. 6, T. 3 min., D. 8 in., will be the erythema dose and this particular technic is standardized. Any set of constants may be employed, but with every set used it is necessary to ascertain the erythema dose as above outlined. After the erythema dose has been established, it is necessary only to split the time to determine fractions thereof. The reason for selecting a young fair skin and a flexor surface is because such skin is more sensitive than dark skin on the extensor surface of older individuals. Obviously, it is preferable, for the sake of safety, to standardize the erythema dose on sensitive normal skin rather than on comparatively insensitive skin. The objection to the biologic method is the amount of time required for standardization.

RADIOMETRIC STANDARDIZATION

This consists of utilizing pastils or photographic paper to determine the time required for the erythema dose with a given set of constants. The method has the advantage of requiring only a few minutes, but it demands considerable experience with at least one reliable type of radiometer.

Before proceeding further it is necessary for the reader to understand and memorize certain physical laws:

1. Intensity varies directly as the square of the voltage (photographic).
2. Intensity varies directly as the voltage (biologic and pastil).
3. Intensity varies directly as the milliamperage.
4. Intensity varies directly as the time.
5. Intensity varies inversely as the square of the distance (unfiltered).

All methods of measurement agree with these laws excepting that relating to

1. Shearer, J. S. Factors Governing Photographic Action of Roentgen Rays, *Am. J. Roentgenol.*, Dec., 1915, p. 900; The Physical Aspects of Roentgen Ray Measurements and Dosage, *Ibid.*, June, 1916, p. 298.
2. Remer, John, and Witherbee, W. D. The Action of the Roentgen Ray in Plate, Pastille and Skin, *Am. J. Roentgenol.*, June, 1917, p. 303.

voltage (spark gap), where photographic and pastil methods give contrary results. Biologic experiments, however, support the pastil, so for unfiltered superficial therapeutic work we must accept the second law while the first is applicable to diagnostic work.

To explain these laws in a different manner: 1. Doubling the spark gap doubles the dose. 2. Doubling the milliamperage doubles the dose. 3. Doubling the time doubles the dose. 4. Doubling the distance gives one quarter of the dose.

It should be clearly understood that these laws pertain only to superficial therapeutic work with unfiltered rays. It is also of the utmost importance to realize that "distance" means from the anode to the skin; not from the glass wall of the roentgen tube to the skin.

It is preferable that the roentgenologist become accustomed to the use of equations, because mathematical formulas allow of visualization and arithmetical computation. The following formula is for *unfiltered* ray in *superficial* therapy:

$$\frac{\text{current} \times \text{voltage} \times \text{time}}{\text{Distance} \times \text{distance}} = \text{intensity at the surface.}$$

or, expressed in arbitrary figures:

$$\frac{20 \times 5 \times 4}{20 \times 20} = \frac{400}{400} = 1$$

Now if voltage is doubled, intensity is doubled; thus:

$$\frac{20 \times 10 \times 4}{20 \times 20} = \frac{800}{400} = 2$$

The same results will be obtained by doubling time or milliamperage.

These laws having been repeatedly controlled by pastil and experiments on living individuals, it became possible to establish a standard formula possessing a definite biologic value with which any dose with any set of factors might be arithmetically computed.

The following standard formula was established as representing the so-called skin unit:

$$\frac{3 \times 3 \times 4}{8 \times 8} = \frac{36}{64} = 1 \text{ skin unit}$$

A digression is necessary here to explain the meaning of a "skin unit." By pastil measurement it represents one unit on the Holzknecht radiometer at skin distance or H 4 at half distance (Hampson 4; Kienbock 8). It is the amount necessary to depilate scalp hair without erythema (epilating dose). It will provoke a slight erythema, if given at one sitting, on very sensitive parts, such as the face of a young girl (erythema dose). It is perfectly safe to administer 1¼ skin units to the scalp, and it sometimes requires this amount and more to effect an erythema of the skin of the body, but for the sake of safety it has seemed preferable to establish the skin unit as above outlined.

STANDARD FORMULA AND ITS USE

In order to demonstrate arithmetical computation the following examples are given: If time is increased by one minute, what will be the result?

$$\frac{3 \times 3 \times 5}{8 \times 8} = \frac{45}{64}$$

The product of this formula is divided by that of the standard formula thus:

$$\frac{45}{64} \times \frac{64}{36} = 1\tfrac{1}{4} \text{ skin units (H 5)}$$

What will be the dose if the spark gap is doubled?

$$\frac{3 \times 6 \times 4}{8 \times 8} = \frac{72}{64} \times \frac{64}{36} = 2 \text{ skin units}$$

Suppose the distance is changed from 8 to 12 inches the result will be:

$$\frac{3 \times 3 \times 4}{12 \times 12} = \frac{36}{144} \times \frac{64}{36} = \frac{64}{36} = 0.44$$

(a little less than ½ skin unit)

With 2 milliamperes, a 6 inch gap and an exposure of 3 minutes, what distance would be required to obtain 1 skin unit?

$$\frac{2 \times 6 \times 3}{x^2} = 1 : 1 : x^2 : 64$$

$$x^2 = 64$$

$$x = 8 \text{ inches distance}$$

If ¼ skin unit were desired, using the same factors, what distance would be required?

$$1 : \tfrac{1}{4} : X^2 : 64$$
$$\tfrac{1}{4} : X^2 = 64$$
$$X^2 = 256$$
$$X = 16 \text{ inches}$$

If the milliamperage is changed from 3 to 2 the result will be:

$$\frac{2\times3\times4}{8\times8} = \frac{24}{64} \times \frac{64}{36} = \text{about } \tfrac{2}{3} \text{ skin unit}$$

If the operator finds it more convenient to employ 2 milliamperes, a 6 inch gap and a distance of 8 inches, how much time will be required for the administration of 1 skin unit?

$$\frac{2\times6\times T}{8\times8} = \frac{12}{64} \times \frac{64}{36} = 3 \text{ minutes}$$

The formula will therefore be:

$$\frac{2\times6\times3}{8\times8} = 1 \text{ skin unit}$$

which may be used as a basis of a dose chart such as herewith appended. This chart is employed for all routine unfiltered work in the author's laboratory.

MILLIAMPERE MINUTES

Not infrequently roentgenologists find it convenient to combine, by multiplication, the tube current in milliamperes, and the time in minutes, and express dosage in terms of milliampere minutes. But it must be clearly understood that the number of milliampere minutes allowable varies with spark gap and the distance. The standard formula $\frac{3\times3\times4}{8\times8}$ expressed in milliampere minutes would be: Sp. G. 3, D. 8, Ma-min. 12. Milliampere minutes may be split in any manner so long as the total is the same: 1 Ma. for 12 minutes; 12 Ma. for 1 minute, 6 Ma. for 2 minutes, etc.

PASTIL READINGS AND ARITHMETICAL COMPUTATION

Arithmetical computation, based on pastil and biologic standardization, has been worked out only for the skin unit and for the maximum epilating dose. If this method is employed for larger doses arithmetical estimation will not correspond with pastil readings. The following is offered as an example: The formula $\frac{2\times6\times3'45''}{8\times8}$ will give an erythema dose (H 1¼ skin distance) as proved repeatedly by pastil measurements and by experiments on human skin. If the time is doubled, other factors remaining unchanged, it is safe to assume that double the amount of ray has reached the irradiated surface. The pastil, however, will not register twice as much color—that is, it will not read 2½; in other words, if it requires 5 minutes to color a pastil from 0 to 1, more than 10 minutes will be consumed (about 12 minutes) before the pastil registers 2. The explanation for this error is that the pastil becomes less sensitive as it assumes color, and it does not obey physical and biological rules after 1 or 1¼ units are passed. In expressing dosage, therefore, it is advisable to indicate exactly what has been done—give the formula used and state whether estimation has been by pastil or by arithmetical computation.

ESSENTIALS OF SUCCESSFUL ROENTGENOGRAPHY

It is not the purpose of the author, in this article, to enter into electrical or mechanical details. Suffice it to say that one must be certain of the reliability of his milliameter, that there is no heavy leakage in the high-tension current, and that the apparatus in general is in good working order. The personal equation has been eliminated, but roentgenological technic is not yet fool-proof and never will be. A reasonable knowledge of electricity and roentgenology is essential.

The standard formula, arithmetical computation and the dose chart contained in this article will be found accurate and reliable if used with an interrupterless transformer (closed magnetic circuit type) of any reliable make and, of course, a Coolidge tube. Now that new types of apparatus are being placed on the market there is likely to be some confusion relative

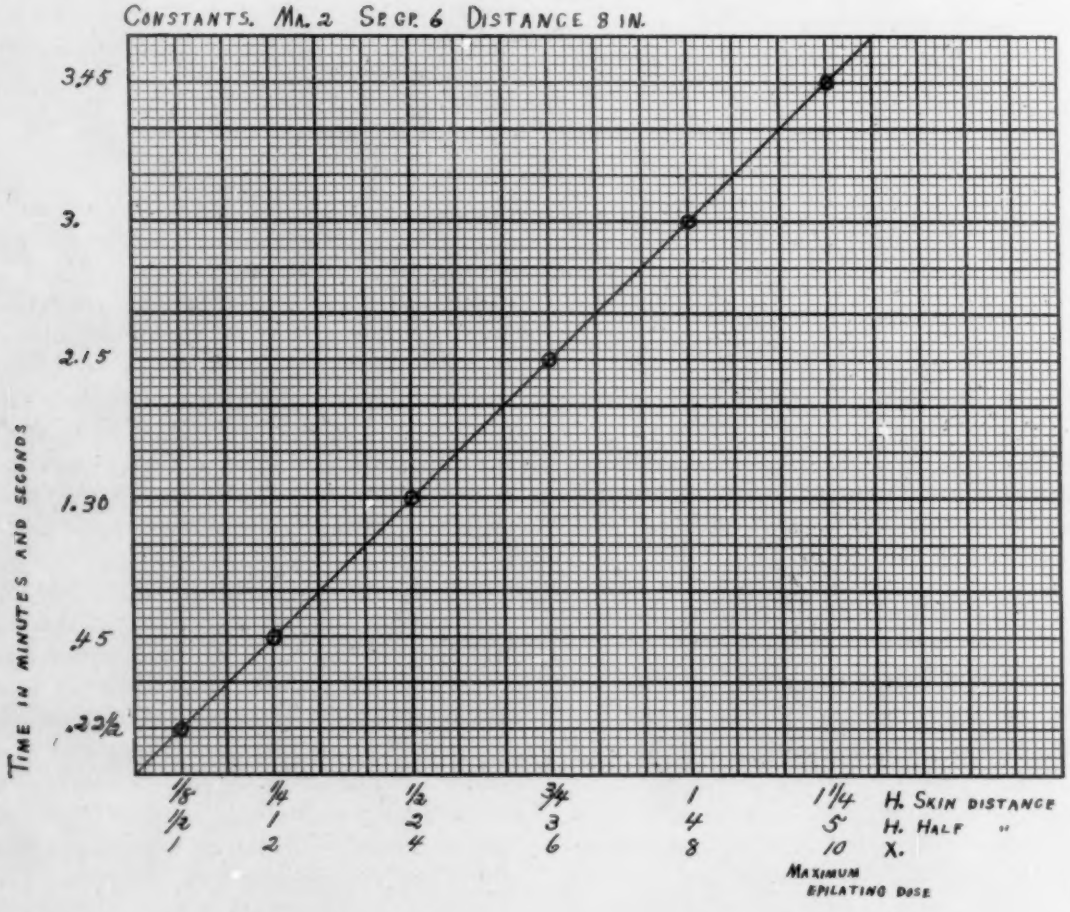
to the term "interrupterless transformer." To avoid this possibility the term is made to include a closed magnetic circuit transformer, operated by alternating current or by a rotary converter in case of direct current supply. The alternating, high-tension current is then rectified by a rectifying switch.

This is the popular type of apparatus at present. The so-called bedside unit may eventually supersede the interrupterless transformer in popularity. The method of dose estimation as outlined in this communication will not answer the requirements of this new apparatus. Experiments are being conducted and it is expected that a dose chart will be established in a short time.

It has seemed difficult for the novice to appreciate that in unfiltered superficial work the therapeutic effect is independent of quality and depends on quantity. That is, whether a 6 inch gap or a 9 inch gap is used makes no difference so long as the dose is correct. This is not absolutely true, for there are instances where it is advisable to employ a very penetrating ray, but in the majority of diseases, while there is a large theoretical difference, it is of no practical importance. For various reasons there is a limit to spark gap lengths in both directions, but for most skin diseases the length of the gap is of little importance providing it is not too short, say not shorter than 5 or 6 inches, and that the amount of rays administered are carefully estimated.

The author desires to thank his associate for invaluable help in the construction of the mathematical formulas.

Dose Chart



DISCUSSION

Dr. Pusey thought that Dr. MacKee was entitled to great credit for working out a technic for giving a measured dose of roentgen rays with accuracy. It was an entirely practical method, and in Dr. Pusey's opinion was a very useful step in the development of the technic of roentgen ray dosage.

Dr. Wise said he had been fortunate enough to be associated with Dr. MacKee and had watched his work and enjoyed his teaching, and had used his technic for some time with very successful results. He thought it was impossible for a man who had not done any roentgen work in the last years to apply this technic and use it with any great amount of judgment without preliminary study. Dr. MacKee was working on a book which would not only give the arithmetical rules, but would tell when to use the proper amount of dosage in the various diseases of the skin. When that was obtainable, with complete instruction on how to use and when to use roentgen ray therapy, the procedure would be free from danger and readily handled by the dermatologist.

Dr. Gilchrist said that Dr. Pusey and Dr. Wise had expressed so fully and so well what all the members felt about Dr. MacKee's valuable paper that he could only express his admiration and appreciation of the paper. Since Dr. MacKee had shown that it was faulty technic and not idiosyncrasy which was apt to cause burns, it behooved all roentgen ray operators to correct their technic. He recalled one instance where the same current which supplied the roentgen ray machine was also used to run the elevator in a hospital; and as a result the strength of the current to the roentgen ray machine would vary, unknown to the operator. In consequence of this he had seen two cases of radiodermatitis and one case of permanent alopecia of the whole scalp in a child because the dose had been measured while the elevator was running so that when the elevator stopped the current was increased in strength, probably double the amount.

Dr. Hazen stated that three or four years ago when he began to use a modern outfit, he had a good deal of trouble with the pastils, and found that there might be trouble in measuring the dosage. He therefore began measuring the spark gap and milliamperage of each dose and found that this could be done without any special device. He recently reported 225 cases of ring-worm of the scalp radiated without any pastil measurements and it worked out very beautifully. He had used a different milliamperage, a different spark gap and different distance, a spark gap of 7¾ inches, 1 minute and 10 seconds' time, and 9 inches' distance for epilating doses, and a milliamperage of 4, and it had worked out admirably in every case.

Dr. White said that he was not a roentgen ray expert but felt that he knew something about the effect of medicines and the behavior of the skin and therefore did not see why all skins would always react in the same way to roentgen rays any more than they did to medicines and other extraneous conditions.

Dr. Haase presented his personal thanks to Dr. MacKee for his contribution, and said that up to the week previous he had been afraid to use the roentgen rays. He thought Dr. MacKee would very shortly give the profession something that could be handled almost as safely as any other remedial agent. He thought that at the same time they would be governed by the reactions, the same as with any other remedial agent, which covered what Dr. White had just said.

Dr. MacKee said that on account of the late hour he would speak only on the subject of idiosyncrasy, a question brought up by Dr. White.

The existence of idiosyncrasy depended largely on the definition given the word. If meant to imply that a minute dose of roentgen ray (1/32–1/16–1/4 of an erythema dose) would produce a first, second or third degree reaction, then roentgen idiosyncrasy was an exceedingly rare phenomenon. In an experience of twenty years the speaker had failed to encounter such a case. If, on the other hand, idiosyncrasy were to include more or less hypersensitiveness or supersensitiveness from various known causes, then idiosyncrasy might be said to be common. The causes for hypersusceptibility were age, complexion, the part of the body, skin affected with certain diseases like mycosis fungoides and skin treated with salicylic acid, chrysarobin, mercury, sulphur, iodin, tar and other irritants.

In previous years, when technic was imperfect the word idiosyncrasy was in constant use. Its use had declined at about the same rate as skill in technic had increased.

A CONSIDERATION OF THE TREATMENT OF THE DISEASES OF THE THYROID WITH SPECIAL REFERENCE TO THE SO-CALLED HYPERTHYROIDISM*

BY JOHN A. LICHTY, M.Ph., M.D.

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IT is intended in this paper to discuss the indications for the various treatments at present available and generally considered applicable for diseases of the thyroid gland. It is also intended to speak somewhat specifically of the present status of the medical treatment, especially in so far as the foundation for our faith in such a treatment is concerned.

When the diseases of the thyroid were first recognized medical treatment was about the only consideration which the various conditions received. By "medical treatment" is meant any medication or measure which does not include "cutting" or definite traumatism of the tissues. Later surgery came to the fore and quite naturally at first claimed the larger part of the field, and more recently the treatment by *x*-rays and radium has been advocated.

The question which generally arises is which treatment shall be applied in which case. For a certain patient shall the treatment be medical, surgical or roentgenological? There is frequent disagreement in answering this question. And even when the question is answered it is not always understood just what particular medical treatment, or what particular surgical measure or roentgenological procedure is to be followed. It is only by careful observation and research on the part of all and the free exchange of candid opinions that we can expect to accomplish the greatest good for this ever increasing number of unfortunate patients.

The differences of opinion which frequently arise among physicians are largely in the consideration of toxic goiters, and true exophthalmic goiter or Graves' disease. But since we have learned that any thyroid gland which is diseased, that is, possessing a definite pathology, may at certain times and under certain circumstances also become toxic, the ground for our differences has been somewhat extended.

However, this need not necessarily be so; in fact it should be quite the opposite. For if we are aware that a so-called simple goiter, or an adenoma, is liable at times to produce toxic disturbances, those conditions should receive prompt and proper attention, be it surgery or roentgenotherapy.

The pathology of the thyroid gland should receive the same consideration as similar pathology does in other parts of the body. Whether in some of these cases it should be an excision or a ligation or a reduction by *x*-rays or radium are questions which will depend largely upon the individual case.

If this is admitted we are brought back to our original statement, and that is that the chief difference of opinion occurs among the toxic goiters, whether they be primarily toxic or are secondary to recognized pathology. Even this difference would not be so great, or lead to so much misunderstanding, if thyroid disturbances were recognized earlier, and treatment were more prompt and more definite. In a paper in 1911 by Dr. John H. Musser on "Problems in the Treatment of Exophthalmic Goiter" (*Am. J. M. Sc.*, 1912, Vol. 143, p. 810), he says in his conclusions: "Finally my conviction is that the surgeon does too much and the internist too little in the treatment of goiter." If he had added that the internist does his "little" too late

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it would have described the conditions possibly more nearly as they were then and are even now.

The early symptoms of disturbances of the thyroid should be easily recognized. The definite loss of weight in spite of an unimpaired appetite; the increased amount of energy discharged; the physical and mental restlessness; the tremor; the loss of vascular tone; the acceleration of the pulse rate and the so-called "internal tremor" to which patients so frequently refer, should call one's attention to the overfunctioning of the thyroid, and should demand immediate consideration. If these symptoms were taken at their face value and early treatment instituted, the results in many patients would be different. The surgeon and the roentgenologist would rarely see them. It is not the purpose of this paper to go into the details of the very early symptoms, but reference should be made to a test which has been suggested by Dr. Emil Goetsch in a recent paper (published in the *Clifton Med. Bull.*, Clifton Springs, N. Y.). It depends upon the activation of the thyroid gland by the subcutaneous injection of adrenalin. It is possible in this way, as it were, to anticipate a thyroid explosion, and to be thus forewarned. In fact, the reaction produced in certain cases of diseased thyroid by this test is so profound that it seems to unbalance the entire endocrin system. Further observations must be made before a true interpretation of the test will be available. But it points the way to vast possibilities for the early diagnosis of thyroid disturbances. The difference in results between the early and prophylactic treatment of thyroid disturbances and the treatment of late or neglected cases is clearly brought out in a comparison of the report of Marine in his work among about 3,000 of the Akron public school girls ("The Prevention of Simple Goiter in Man," *Arch. Int. Med.*, July, 1918), and that of W. Hale White on the results of the treatment of exophthalmic goiter as experienced in Guys Hospital ("The Outlook of Sufferers from Exophthalmic Goiter," *Quart. J. Med.*, Oxford, 1910–11). It is true Marine speaks of simple goiter while Hale White speaks of exophthalmic goiter; yet the one writes with the enthusiasm and hope which come from preventing a disease or from treating it in its very early stages, while the other seems simply to record the uninterrupted course and outcome of 169 apparently advanced cases admitted to Guys Hospital between 1894 and 1909.

In the interval between Hale White's report (1909) and Marine's report (1918), great advances have been made in our knowledge of the diseases and disturbances of the thyroid. The advances have come largely from laboratory observation. Points were confirmed which formerly had been surmised but were not definitely understood. For example, it was long recognized that the patient with exophthalmic goiter loses more or less weight. But it was not until Dr. E. F. DuBois had demonstrated satisfactorily that the basal metabolism in severe cases may be 75 per cent or more above the average, whereas in mild cases it may be only 50 per cent, that we had one clear and rational indication for treatment. We now prescribe unhesitatingly a full diet of very high caloric value. From DuBois' experiments and observations it appears without any doubt that increase in basal metabolism is in proportion to the severity of the disease. ("Metabolism in Exophthalmic Goiter," Dr. E. F. DuBois, *Arch. Int. Med.*, Vol. 17, p. 915.) This has been so generally recognized that some clinicians in certain cases are unwilling to make a diagnosis of hyperthyroidism until the basal metabolism is determined.

Another fact which has pointed the way in treatment is that brought out by Dr. W. B. Cannon in his work on the innervation of the thyroid. He concludes that the nerves distributed to the thyroid cells belong to the sympathetic and not to the vagus supply, and that their effects are not indirect through alterations of the blood flow; indeed that they are true secretory

nerves. The thyroid gland is subject to that division of the nervous system which is brought into action in emotional excitement. (Cannon, *Boston M. & S. J.*, 1916, Vol. 175, p. 152.) The experiences observed in the recent great war go far in confirming the work of Cannon.

This explanation of Cannon's thus again points definitely the way from etiology to a rational treatment. It implies a condition of imbalanced nervous function which must be restored. This is a definitely medical condition, and no one unto this day has better outlined such a medical treatment than S. Weir Mitchell in his method of rest treatment. The possibility of restoring nerve function and mental balance by the proper application of the principles laid down by Mitchell is recognized by all. The late Dr. Janeway in discussing a collection of papers referring to thyroid conditions and the various treatments therefor said: "I have seen that symptoms when recognized (early) permit of successful medical treatment in spite of the fact that, for the patients studied nowadays in hospitals, surgery is usually necessary. One of the reasons for the difference of opinion between surgical and medical men is that we tend more and more to treat our patients in hospitals. In private patients who early will cooperate, however, the medical man may accomplish cures, and cures which are permanent. Such patients must be carefully selected and more carefully managed." (Dr. T. C. Janeway, *Boston M. & S. J.*, 1916, Vol. 175, p. 685.)

This brings us to the crux of the goiter question in so far as treatment is concerned. It is the proper selection of cases for the various treatments. Early in my medical practice I determined upon a classification of goiter patients which has been very helpful to me and which up to the present I have not seen fit to abandon. It furnishes a rather satisfactory working basis for the determination of the proper treatment in the individual patient. It does not preclude any classification thus far suggested of diseases of the thyroid gland based upon demonstrable and well-recognized pathology. Patients having diseases of the thyroid gland are divided into four groups:

Group I.—Those patients having hyper- or hypo-thyroidism without any apparent pathological change in the gland. No change in the size or shape of the thyroid is demonstrable physically. These may be early cases in which later pathology will become manifest, or they may be well-advanced cases with no pathology of the gland. If one is keen in recognizing the early symptoms of thyroid disturbance, this class may be large. The symptom-complex, however, is usually quite definite. A study of the basal metabolism and possibly the application of the before-mentioned Goetsch test may be necessary to confirm the diagnosis in doubtful cases.

The treatment in these cases is definitely medical, which includes, as stated heretofore, any means which are non-surgical. I do not know of any attempts at treatment by *x*-rays in these cases, unless it be in those in which the thymus gland is enlarged. I have recognized two such cases, one of which was apparently cured two years ago by Dr. George C. Johnston and Dr. George W. Grier with *x*-ray treatment. This case will be published later after sufficient time has elapsed to warrant a definite statement.

Group II.—Those patients having an enlargement of the thyroid, but in which from the age of the patient and the absence of certain symptoms, the diagnosis of adolescent thyroid may be made. It occurs in young girls about the time of the establishment of the menstrual period. It may also occur in boys at the age of puberty. The enlargement is usually temporary. There are of course notable exceptions. If any definite treatment is necessary it is medical. Usually time and careful prophylactic measures may prevent the hyperthyroid syndrome.

One of my cases was a notable exception. A young girl was brought to me at the age

of twelve with a slightly enlarged thyroid. It had been noticed for about four years, or since she was eight years old. Advice had already been given that it was an adolescent goiter and would likely disappear in due time. There was no reason for advising anything to the contrary, as there were no symptoms. The tonsils were diseased and were removed without any untoward symptoms. Definite prophylactic care was instituted. When the periods came on at the age of fourteen there was no change in the size of the gland, but at the end of two years it was larger. No symptoms of hyperthyroidism were noticed, but the patient wished a lobectomy for cosmetic purposes if for nothing else. A partial lobectomy was done under local anæsthesia. The right lobe and the isthmus were removed. It proved to be a parenchymatous hyperplasia. Within a year of the operation the remaining lobe enlarged rapidly, and symptoms of hyperthyroidism were noted. A second operation was considered but finally it was decided to apply *x*-rays. After eighteen applications by Dr. Russell H. Boggs the swelling had about disappeared. This was three years ago. The patient lost her symptoms and seemed well. She has since been in college and has done heavy work. She had an operation for appendicitis and is living a normal life. The neck is normal and there are no symptoms.

This is undoubtedly an exceptional case, for among a large number of this group of cases this is the only one that seemed to require other than medical care. Most of these patients resume a normal thyroid after the menstrual periods are fully established. On account of this it is extremely difficult to estimate the real value of any treatment which may be instituted.

Group III.—Those patients having an enlarged thyroid with a definite hyperthyroidism active or at times potential. The enlargement may be due to a hyperplasia of a parenchymatous type (true Graves'), or it may be a colloid goiter, a cyst, an adenoma, or any combination of these conditions. This is a group of patients in which the course of treatment is occasionally extremely difficult to decide upon. It depends largely upon the stage of the disease or condition present at the very time the patient is seeking advice. Two principles must be kept in mind: (1) Any pathology of the thyroid gland should receive the same prompt consideration as similar pathology does elsewhere in the body. If the indications are for surgery it should be undertaken, if for *x*-rays the same obtains. More will be said of this when discussing Group IV. (2) Due regard must be given to the stage, or degree, of secretion of the thyroid gland, determined by its effect upon the general health of the patient, before deciding upon any course of treatment. In toxic goiters of extreme degree, and in true exophthalmic goiters, medical treatment may be the only *safe* treatment at first, and may be a necessary preliminary to later surgical or *x*-ray treatment. If after a successful course of medical treatment the thyroid gland still presents such pathology as would ordinarily require surgical interference, surgery should be undertaken promptly before there is a recurrence of disturbed function.

In certain cases the intoxication may have reached such a stage that medical treatment, i.e., physical and mental rest, abundance of food, support of the circulation and nerve sedatives, however carefully prescribed, will not bring about such amelioration as to make an operation a safe procedure. Under such circumstances it may still be safe to use *x*-ray treatment, either as a preliminary to operation, or without any thought of a subsequent operation. In these cases *x*-ray treatment has been most satisfactory. In several cases where it was begun only as a preliminary treatment, the results were so satisfactory that it was continued until the symptoms subsided and the swelling practically disappeared. Of course there are occasionally fulminating cases which run a rapid course and for which no treatment however carefully planned is of any avail. One such case

seen some years ago was most remarkable.

The patient was a child's nurse. She had charge of two only children in a family. Both contracted scarlet fever and died violent deaths within a week on account of kidney complications associated with uremic convulsions. The nurse, who was very much attached to the children, harbored the idea that she was directly responsible for bringing about the contagion. She could not be convinced to the contrary and brooded continually. She had previously been perfectly well. Her pulse became rapid, the thyroid gland enlarged, the eyes protruded and tremor developed. The diagnosis was evident. Notwithstanding every care, she became delirious, later comatose and died. The whole course of the disease was run in just two weeks. It will be seen that in Group III the success of any treatment is largely dependent upon the proper selection of cases. The problem is practically the same as it is in gastric and duodenal ulcer. There are some patients who will get well with medical treatment and remain permanently well, while there are conditions in others which will interfere with recovery until surgery is undertaken, or *x*-rays are applied, and finally there are those who will not recover with any treatment. These are the fulminating cases, or the neglected chronic cases with definite vascular or nervous disturbances.

Group IV.—Those patients having definite pathology of the thyroid, enlargement, without any disturbances of thyroid function. This group includes malignant tumors such as carcinomata, also the so-called "simple" goiters, or colloid growths, as well as the adenomata and cysts, and inflammatory reactions due to tubercular, luetic or other infections.

These are imperatively surgical conditions, especially when malignant or when producing pressure symptoms interfering with breathing or swallowing. Certain of these conditions, such as the adenomata and colloid goiters, yield satisfactorily to *x*-ray treatment, which under certain circumstances may be preferable; but in emergencies surgery is imperative.

By following such a grouping of patients as just described I have been able to advise more definitely as to the line of procedure in disease of the thyroid gland. There are of course border-line cases, but this occurs in any classification. The first group includes strictly medical cases; the second group may need nothing but prophylactic care; when they need more they are already in the third group; the third group may be medical for a time and later surgical or *x*-ray or both; the fourth group is surgical always, but presents an enticing field for *x*-ray investigation.

The physician who has only one treatment, be it medical, surgical, or *x*-ray, either sees only one class of cases or fails to recognize a large class which might be successfully treated otherwise. While I would prefer to have the surgeon and the roentgenologist settle their own differences, if there are any, on this question, as an internist I feel it my duty to express an opinion. The internist usually sees the cases first, no matter what stage of the disease may be presented. If medical treatment is not indicated, or if medical treatment has failed, he should be immediately in touch with the surgeon or the roentgenologist, or both. If he is as familiar with his case as he should be, he will go into such a consultation with pretty definite convictions. From my own experience I would say that as between surgery and *x*-rays, the former has a far larger field of application, and in skillful hands is comparatively safe. It has the added advantage of furnishing definite information, in that the tissue removed may be studied, and the nature of the pathology determined. This is of the utmost importance for the future conduct of the case. The roentgenologist necessarily is frequently not altogether sure of the condition with which he is dealing.

The results of operative treatment are

sometimes immediate, so that the patient is able, in a short time, to return to his usual life or occupation.

On the other hand, the *x*-ray treatment presents some advantages which cannot be passed by and which appeal to me very strongly. It is comparatively without danger; it leaves no scar; it is painless and gives very little inconvenience; if it is unsuccessful, surgery may be undertaken with possibly less risk. (Dr. Malcolm Seymour, "The Advantages of *X*-Ray Treatment," *Boston M. & S. J.*, 1916, Vol. 175, p. 568.)

The absolute safety of the procedure may be questioned. May it not be possible by *x*-rays to destroy the function of the gland entirely, as happens in the radiation of the ovaries, and produce a myxedema? The surgeon has been reminded of the dangers of removing too much tissue from the time he entered this field, and there are records of unfortunate results. What assurance has the roentgenologist that he may not have a similar experience? These are some of the questions which concern the internist especially.

In conclusion the following summary might be offered:

(1) Exophthalmic goiter, or hyperthyroidism from other causes, should be recognized early and treated promptly.

(2) The earlier it is recognized the more likely medical treatment will be sufficient and give permanent results.

(3) The neglected cases, or the cases having definite pathology besides, are likely to require surgery or *x*-ray treatment.

(4) The *x*-ray treatment of the enlarged thyroid presents most attractive advantages, but as yet the indications for its use do not seem so definite, and the results are not so certain.

(5) In hyperthyroidism the roentgenologist and the surgeon, at best, can only break through a vicious circle for which the internist may or may not have been responsible.

TREATMENT OF GOITER BY RADIATION*

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A SUFFICIENT number of cases of goiter had been treated in some roentgen laboratories throughout the world even ten or twelve years ago to give roentgen rays an important place in the treatment of certain forms of thyroidism; and with the advancement made since then their efficacy is to-day thoroughly recognized in a large proportion of properly selected cases. While many cases of goiter in the past ten years have been operated upon surgically, it is useless to claim that this is the only method to be applied, because in the same period an increasingly large number of cases have been cured by radiation and others by medication.

Before positive facts are established concerning the value of any method, a fairly definite conception of the life history of the disease must be obtained, as well as knowledge and comparison of the ultimate results in the case of patients undergoing the various forms of treatment and of those who have received no treatment at all. And results of the different methods must be compared for a period of at least five years in order to determine the differences from those to be expected in the natural course of the disease.

The physician best able to treat goiter must have developed sufficient judgment to enable him to select the medical, surgical or roentgenological treatment best adapted for each individual case. This can be determined only by a careful study of many factors. In the past there have

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been operations performed on the wrong class of cases at the wrong time, either too late, or at the height of the toxic symptoms. The same can be said of many roentgenologists; they have treated cystic and other forms of goiters and expected results, and many cases had been treated too long medically. When medical treatment is employed, the physician must realize that rest is an important factor, just as the surgeon, operating on goiter every day, realizes that an advanced case of exophthalmic goiter is inoperable unless the patient improves under rest in bed within a few days. The surgeon who operates on a case before making a careful study of the patient is just as injudicious as anyone who treats all forms of enlarged thyroids, regardless of the type, by radiation.

Before a surgeon or roentgenologist is qualified, he must have made a study of the physiology, the pathology, and the changes that take place in the glands, supplemented by a wide and comprehensive experience. Removing three-fourths to seven-eighths of the gland, giving a roentgen treatment, or applying radium in a hit or miss manner, is not treating goiter intelligently. In some cases in which even seven-eighths of the gland have been removed, the one-eighth left becomes so much hypertrophied that within a short time the patient may be worse than before. It has long been known that the size of the thyroid is not always in proportion to the toxic symptoms, and the other ductless glands often play a very active part in goiter. Toxic goiter is a disease of exacerbations and remissions. In the first place the diagnosis of goiter must be made and the further facts determined whether the enlargement of the neck is producing a systemic poisoning and whether there are other things that may be the matter with the patient.

Since this is a newer form of treatment, it is natural that there are still somewhat diversified opinions even among the roentgenologists as well as the medical profession. At present many roentgenologists have treated and studied a large number of cases, while others have only treated a few cases and have not given the subject serious consideration.

Tremendous advancement has been made in recent years in our knowledge of the physiology, pathology and treatment of the ductless glands. Improvement has been shown in exophthalmic goiter, by treating either thyroid, thymus or ovaries alone, but most of those who have treated goiter by radiation have treated the thyroid alone. It has been known for many years that thyroidectomy does not always remove all the symptoms of Graves' disease, and that in many instances the patients who have been operated upon are greatly benefited by roentgen treatment of the thymus or ovaries afterwards. It has been estimated by some investigators of exophthalmic goiter that the thymus is enlarged more or less in 90 per cent of the cases. When the thymus gland is greatly enlarged, patients do not stand operation well, frequently suffering severe shock from the operation, sometimes followed by death. A majority of the cases of exophthalmic goiter are of thyroid origin, but they may be complicated by thymic hyperplasia. It is true that we have a few cases of Graves' disease of purely thymic goiter, but a large proportion of the cases are either of purely thyroid origin or a combination of both forms. This explains why those who have only treated the thymus alone have not had uniform and lasting results.

It is natural to expect results from both roentgen rays and radium in goiter, since both have such pronounced effect on glandular or epithelial cells. It is not necessary at this time to describe the physiological action of the roentgen rays or radium, any further than to say that the glandular substance can be made to undergo a fibrous degeneration. It is well known to all roentgenologists that radiation has a wide latitude, depending upon the dosage on glandular cells. Small doses will only retard the activity or the function of the gland, but by increasing the quantity of radiation the injury becomes more pro-

nounced and, as before stated, many of the cells are completely destroyed. This explains how both roentgen rays and radium reduce the activity of the thyroid and relieve the symptoms in goiter. The gland undergoing a fibrous degeneration explains why all the symptoms may disappear after a course of radiation, and the gland itself may only have been reduced one half or one third.

A satisfactory classification of goiter is difficult, owing to the necessity of bringing into harmony the pathological with the clinical facts. For a long time goiter has been grouped roughly as exophthalmic and simple goiter, but at present it is well known that such a classification does not properly represent the clinical and pathological conditions. Crotti classifies enlargements of the thyroid gland as benign and malignant tumors and inflammations. Benign tumors or goiters (those under discussion) he divides into parenchymatous and colloid goiters. The parenchymatous are subdivided into physiological, nontoxic and thyroid-toxic; and the colloid into cystic, fibrous, calcareous and osseous. The microscopical picture of parenchymatous goiter is a picture of a more or less normal gland in which the structures show an increase in size and number but have more or less kept their natural relation to each other. Colloid goiter varies in degree considerably, and the main characteristic is an increase in the quantity of colloid. Colloid degeneration may be localized in a portion of the thyroid or may affect the entire gland. Colloid goiter may later give rise to a cyst. The cyst may produce a chronic irritation or inflammation, thus forming a fibrous goiter. Even in diffuse colloid goiter every follicle has not undergone colloid degeneration. There are always a number of normal vesicles between the degenerated follicles, which will proliferate and form new alveoli to make up for the lost function of the degenerated follicles. Adenomatous goiter of either fetal or adult type may be encapsulated or diffuse, and pathologically show a regeneration of a previous atrophic parenchyma.

At the Mayo clinic they have classified goiter as hyperplastic and non-hyperplastic. Between January 1, 1909, and January 1, 1913, of 2917 cases coming to operation 42.8 per cent were hyperplastic and 57.2 per cent were non-hyperplastic. Of the hyperplastic, 99.2 per cent were toxic and .8 per cent were atoxic. Wilson of the Mayo clinic states: "The pathology of the thyroid in true exophthalmic goiter is essentially a primary parenchymatous hypertrophy and hyperplasia, i.e., an increased amount of functionating parenchyma, associated with an increased absorption. The process is an acute one. The pathology of atoxic simple goiter is marked essentially by atrophic parenchyma, decreased function and decreased absorption. The process is a chronic one. The pathology of toxic non-exophthalmic goiter (i.e., those resembling exophthalmic goiter) is one of increased parenchyma through regenerative processes in atrophic parenchyma of the fetal type, with an increase in each instance of secretory activity and of absorption. The process is a chronic one."

The symptoms of hyperthyroidism vary somewhat in type as well as intensity, and are not proportionate in many cases to the size of the thyroid. There are all grades of hyperthyroidism, varying from a typical case, with all the symptoms well marked, to a case with simple nervousness, characterized by slight cardiac irritability, muscular tremor, with no or only slight exopthalmos, and the thyroid may vary in size from slight or no enlargement to enlargement of considerable size.

A fairly satisfactory working basis has been established at present through laboratory and clinical experience to determine the treatment of the overaction of the thyroid in exophthalmic goiter of the varying degrees and the method of treatment in glandular loss or activity or hypothyroidism. Further experience has shown that the two types of thyroidism may merge to a certain degree, certain clinical symptoms of hyperthyroidism often being overlapped by those of hypothyroidism.

The transitory symptoms produced by changes in the thyroid may not be due to hyperthyroidism or to hypothyroidism, but rather to dysthyroidism. This alone brings us up to the point which should show the profession that an excision of part of the thyroid gland or treatment by radiation requires a great deal of judgment. Experiments on animals have shown that there is a superabundance of the ductless glands with wide range of their functional activity which often permits the removal of a large proportion of the glands without apparent loss to the system. It has been estimated that a child needs at least one third of the thyroid, while the adult may maintain perfect health with one sixth of the gland.

There is a class of cases in which the value of roentgen therapy is too little appreciated even by men practiced in its use, i.e., the small or moderate sized goiter of adolescent females with few or no symptoms. Hitherto the best advice we could give those cases was to let their goiters alone. Medical treatment offered a problematical result; and since the cosmetic consideration was of chief concern, a surgical operation, with its resulting scar, was undertaken with reluctance. The thyroid over-activity of adolescent girls is no doubt usually physiological and compensatory, and may require nothing more than a careful mode of life. Moreover, the majority of these goiters disappear in a few years or a few months spontaneously. It is true we are unable to say which cases belong to the majority that would be cured by nature's method, or which would lead to a lifetime of chronic hyperthyroidism, by the conversion of glandular into cystic tissue, with its resulting permanent unsightly tumor which is always a potential danger by reason of mechanical pressure. In several such cases I undertook roentgen treatment, somewhat reluctantly, merely to secure a cosmetic effect. I was amazed to find that the treatment resulted not only in a distinct gain of weight and bodily strength, but also in the correction of a psychic instability which has been looked on as a matter of character rather than disease. From frivolous, flighty, irresponsible girlhood the patient passed into serene, well-ordered womanhood. In other words, they were suffering from hyperthyroidism, in so slight a degree as to give no characteristic symptoms, yet sufficiently to affect both physical and psychic strength.

When it becomes general practice to regulate, by judicious roentgenization, even minor aberrations of the thyroid function appearing at adolescence, I believe that we will not only prevent the chronic hyperthyroids and disfiguring cystic goiters of later life, but also add appreciably to the health and welfare of the community. C. H. Mayo, in speaking of goiter of adolescence, states: "Such glands are subject to degeneration, fibrous, cystic or calcareous." I began to treat a few adolescent goiters about twelve years ago, and I am glad to say that not any of these cases which were treated by the roentgen rays, so far as I know, have ever developed cystic or other degenerative changes, and that the results since that time in this class of cases have been uniformly successful.

There are three well known forms of treatment of goiter at the present time, namely, medical, roentgenological and surgical. The medical should always be considered first, as changes in the thyroid gland are produced by various conditions, such as infections, fatigue, pregnancy, shock, etc., and many times the symptoms will disappear when the patient is kept at rest under medical treatment. Focal infection should always be searched for and when found, treated promptly. There came under my observation a case following post-partum hemorrhage, and within six weeks all the symptoms of goiter had entirely disappeared, and the patient has never had any return.

Frequently in the past the statement has been made that the non-surgical treatment of goiter is attended with a higher rate of mortality than those treated surgically. The surgeon, like the roent-

genologist, sees the failure of others. The surgeon usually sees the failures of roentgen therapy more often than the successes, and the surgical failures are seen by the internist and are often referred to the roentgenologists. For the treatment of ductless glands roentgen therapy is not given the proper credence in some sections of the country, due to improper selection of cases. There is no question that treating a case too long medically, unless the patient is kept in bed, may be followed by permanent damage to various structures of the body; and since roentgen treatment has proved efficient and is not dangerous in the hands of a skilled roentgenotherapeutist, there is no necessity of delaying the treatment too long. The sooner roentgen treatment is given the more promptly the symptoms will be relieved, and the less radiation is required. Usually the younger the patient the more promptly the symptoms will yield.

When raying a case with grave thyroid autointoxication, it is necessary for us to begin carefully, because often after a week or ten days roentgenization a stimulation of the gland with an increase of the symptoms may result. This is always followed by relief of the symptoms to a certain extent after the first series of treatments. If the case is exhausted, the mere moving of the patient from the room to the roentgen laboratory, in addition to the excitement caused by the treatment, may greatly aggravate the symptoms. In such extreme cases it is usually best to wait until the acute symptoms have partially subsided before giving the treatment. The writer had one patient referred for treatment in which the symptoms were extreme, and bringing her in an automobile so greatly aggravated her symptoms that it was undoubtedly a dangerous procedure.

Now, with our present knowledge of roentgen rays in the treatment of goiter, patients should never be allowed to reach so precarious a stage before this method of treatment has been given at least a fair trial. Treating the thymus and ovaries is not sufficient, but the thyroid should usually receive the greater proportion of the treatment. Often patients suffering from goiter in the advanced stage are very easily discouraged, and to avoid disappointments it is important to have a thorough understanding with the patient before the treatment is given.

Patients with simple goiter having only an enlargement of the gland accompanied by nervous symptoms, will receive much benefit from a few roentgen treatments. The enlargement, which may be only in one lobe, can be checked and reduced in size, and the patient's health will be greatly improved. Raying a lobe of the thyroid is not any more dangerous than removing it surgically, because if the treatment is given carefully you can stop on the safe side. In cases of simple goiter, which are just beginning to show symptoms of the exophthalmic type, roentgen treatment should be given at once, because nearly all of these will be promptly relieved.

In the exophthalmic type, in which the symptoms are marked and damage has been done to other structures of the body, we must be careful in giving a prognosis as well as in giving the roentgen treatment. The gland in these cases is often easily affected, and the patient may be suffering from destruction or damage of the heart, nervous system, etc., and instead of hypersecretions of the thyroid, the patient is almost ready to pass from a hyper- into a hypo- condition. Then very heavy roentgen treatment is not indicated. Lately I have had such a patient, all whose symptoms were relieved after the first few roentgen treatments. She gained forty pounds in weight and her nervous system greatly improved. This is a case which I believe will become myxedema, and while the roentgen treatment relieved her symptoms, it is a question whether her thymus gland should not have been treated, omitting the thyroid, at least at first.

The treatment of goiter by the roentgen rays is major roentgenological work, and should not be attempted unless the physician is familiar with the disease as well

as the technique and physiological actions of the roentgen rays on the thyroid gland. Keen advises that the operation should be performed only by a surgeon who has had experience and practice in the removal of the thyroid gland. This applies with equal force to the roentgenologist, because we are dealing with a powerful agent.

The first improvement noted is the reduction of the pulse rate. Various authorities have found the decrease in pulse rate in 90 per cent of the cases, and it is possibly the best guide we have in regard to giving the treatment, because it has been pointed out that the stability of the pulse is more important than the reduction itself; that is, when it does not fluctuate with excitement or exertion. I have found that an increase in weight occurred in at least one half to three fourths of the cases after the first series of roentgen treatments. As soon as the pulse rate is reduced and becomes more or less stable and the patient increases in weight, the nervous symptoms, such as excitability, insomnia, etc., improve rapidly. The exophthalmos improved in many of the cases I have treated. Some authorities state that improvement is noted in fifty per cent of such cases. In my cases there was a reduction of the thyroid gland, at least to a certain extent, in over two-thirds of the cases of the exophthalmic type, and in about one-third of the cases the reduction was very marked. As before stated, we must go cautiously, and when the hypersecretion is reduced to normal, we must stop treatment, regardless of the size of the thyroid, because if carried further there is danger of producing myxedema. Further treatment can be given when it is deemed necessary.

There is some difference of opinion among physicians and surgeons as to when a patient is cured medically or surgically, some regarding a class of cases cured, while others regard them as only improved. Patients are usually not satisfied until there is a complete disappearance of the objective as well as the subjective symptoms. In the early cases both the objective and subjective symptoms will nearly always disappear, but when the disease has progressed beyond certain limits and when other organs are pathologically damaged, the patient will recover slowly under any method of treatment. Some advanced cases are symptomatically cured, but some of the objective symptoms are slow in disappearing or the deformity caused by the disease may never disappear, such as enlargement of the thyroid gland. Or in many instances the exophthalmos still remains in a more or less degree, yet the patient is apparently cured. In some instances the tachycardia still remains with certain nervous symptoms, yet the patient increases in weight and feels well. In these cases the question arises whether these symptoms are due to an acquired pathological condition instead of a toxic goiter. No matter whether the case is treated medically, radiotherapeutically or surgically, we must not be contented with the immediate results. In all cases the patient should remain under medical instruction for rather a long time.

INDICATIONS FOR ROENTGEN OR RADIUM TREATMENT

1. All forms of exophthalmic goiter derive benefit from both forms of radiation, and the symptoms can be relieved or the patient can be symptomatically cured in 80 per cent of the cases unless the disease is too far advanced. Nearly all cases can be both symptomatically and objectively cured.

2. The roentgen rays are useful in reducing the overactivity of the thyroid gland in exophthalmic goiter before operation, where the tumor is large and the symptoms are so intense as to make operation dangerous. When given as an anteoperative procedure, it is advisable to operate within four to six weeks, before fibrous tissue formation has taken place.

3. In relapses after operation for exophthalmic goiter, radiation should always be employed after a careful study of the ductless glands has been made, rather than the contemplation of a second operation.

4. Exophthalmic goiter in which other ductless glands play an important part, particularly if the thyroid is of only small or moderate size, should be given radiotherapy.

5. Adolescent goiters, which do not respond within a reasonable time to medical treatment, are benefited by radiation.

CONTRA-INDICATIONS FOR *x*-RAY

1. Colloid, cystic, fibrous and nodular goiter.

2. Goiter causing marked pressure without toxic symptoms.

3. Intra-thoracic goiters.

DISCUSSION

DR. ISAAC GERBER.—We have had the privilege of listening to two extremely important papers. Too much treatment is being done with little basic understanding of the physiology and pathology of the thyroid disturbances. Unfortunately Dr. Boggs mentioned nothing whatever of the technique of his treatment. It may sound rather impertinent to introduce anything like technical problems when we are discussing general principles, but the amount of available information, especially that which we are able to obtain from the text-books in English, is not at all satisfactory. Some men are indeed advocating the treatment of thyroid dyscrasias by methods which are exactly similar to those used in the treatment of malignancy. In fact in one of the most recent books on radiotherapy it is stated that the author intends to produce tanning in all of his cases of goiter. I believe that is very injudicious. From the statements we have heard today outlined by Dr. Lichty on the deep, underlying disturbances which we are dealing with, you will understand that when you produce tanning and atrophy of the skin, telangiectases and all that, that you are producing disturbances that will add to the psychic instability and defeat every bit of good that the radiation treatment has produced. We are not dealing with malignant disease. The treatment is not to be accomplished in a short time to save life, except in the fulminating cases in which treatment is of no avail. We are dealing with a complicated disturbance of the endocrine organs. What we are attempting to do is to break up the vicious circle of disturbance as was mentioned by Dr. Lichty. With all due respect to the histological observations, the radiation treatment of exophthalmic goiter is not yet entirely on a rational basis. We are not attempting merely to produce a partial atrophy of the thyroid. There is something more to the treatment. Just what the rest is I do not pretend to know, except that we are attempting to break the vicious circle of the end changes of ductless glands. This may require in some cases only a little push outside the circle to bring about a complete cure. In others it takes more time. Under these circumstances the doses are too high. We do not need an erythema dose, as is used in breast cancer. As a matter of fact, the same results clinically will be produced by administering one third to one half of a full erythema dose. You will very frequently with one treatment obtain an amelioration of the symptoms and reduction of *nervousness* and sweating just the same as is accomplished by the more intensive methods. I want to put in a plea not to treat these dyscrasias in the same way we deal with malignant disease. We are dealing with delicate problems, which require delicate treatment. As the treatment is in large part still empirical, we ought to go carefully with smaller doses. Then we will not produce those disturbances of damaging the healthy cells, and perhaps then we will not damage the vagus nerve and the cervical sympathetic ganglia.

DR. GEORGE W. HOLMES.—I can only agree with what has been said by the authors of the papers and perhaps say a little about the work we have been doing at the Massachusetts General Hospital. We have had a team consisting of an internist, a surgeon, and a roentgenologist, so that our cases have been studied from three different angles, an unusually fortunate arrangement for doing this work.

One of the things which has been spoken of, but not sufficiently emphasized I think, is the importance of the basal metabolism test. The cases we have treated have all been referred from the clinical department of the Hospital, and you would expect very good diagnoses; but when those cases were studied by the internists especially interested in the subject, a pretty large percentage have proven not to be cases of hyper-thyroidism. So that, if we treat either by the *x*-ray or surgery cases diagnosed by the average internist, I believe we will get a number of cases which are not true cases of hyperthyroidism.

The basal metabolism also gives us a direct

check on the amount of toxemia that the patient is suffering from, the amount of activity of the gland, and by having it done at intervals during the treatment we get a check on the result of our dosage, so that we can increase it or decrease it, as the case requires, and then by so following the case we know when to stop direct treatment of the gland.

We have studied about 250 cases treated by *x*-ray. We have also had something like 40 or 50 cases that had surgery alone and a similar number had medical treatment only. Recently we wrote to these patients requesting them to return for re-examination, most of them have been under observation for about five years. Now a striking thing is that all who reported are well, a few had died following operation, and some from intercurrent disease, such as influenza. It did not seem to make any difference whether they were treated by surgery, medicine, or *x*-ray.

Of course, we cannot say what would happen if we had all of these cases early—whether or not we would then avoid the bad hearts which patients get from going through thyroid disease five to six years, I don't know.

Dr. Means and Dr. Aub have carried on the metabolism tests and thoroughly studied these cases. What I say now is largely quoted from them. Dr. Means plotted curves based on the metabolism, which are very interesting. The surgical cases have a sharp drop immediately after operation, some of them going down to nearly normal, but in a short time there is a distinct rise so that they go back to nearly where they were before operation, and this is the time that the surgical case comes in for *x*-ray treatment, and then, whether they have treatment or not, they drop and within five years they are normal.

If you start treating with *x*-ray instead of surgery, there is a steady drop and they get to normal about the same time the surgical case does. So that if you judge from end results, there is practically no difference in the two forms of treatment. None of the cases showed any improvement from drugs alone. That is, if if you put the patient to bed, you will get a drop down to a certain point; drugs will not increase this drop. After they reach that first drop from rest, we must decide upon either surgery or *x*-ray.

As to what class of case to treat by *x*-ray, I think we have gradually got round to using the metabolism test as a guide. If they have hyperthyroidism we treat whether the gland is enlarged or not. If there is no toxemia, as evidence by a normal metabolism, *x*-ray treatment is not indicated, no matter what the size of the gland may be. I have a case, a man with well marked hyperthyroidism, who drives a heavy auto truck. He has never had any enlargement of the gland, either external or internal, but by taking treatment he has been able to go on with his work, and at the present time is free from all symptoms except exophthalmos.

The treatment should be based on the amount of intoxication.

Another thing which Dr. Means has shown is the value of studying the relation of the pulse to the intoxication. Usually a rapid pulse and a high metabolism go together, but occasionally a case may have a relatively slow pulse and a high metabolism. This is the type of case which dies under operation. If a patient does not get a drop in metabolism with complete rest, it is probably unsafe to operate. At least, this has been our experience.

What I want to emphasize is the necessity of having these cases studied carefully by a good internist and then select them very carefully for treatment, having repeated basal metabolism tests done. We feel it is very much better than the Goetsch test.

Dr. George E. Pfahler.—I first want to thank Dr. Lichty for coming to us and to express my appreciation in general of the papers and the discussions. I agree first of all that we must be careful about our diagnoses, and we must go a step farther than merely classifying the case; we must search for the cause, and removing the cause will often be the means of curing the patient. I am quite confident that in some cases at least focal infection is a cause and should be searched for. Whether it is the cause or simply keeps the disease going, I do not know, but it should at least be removed in the course of treatment. I never like to treat a case except in association with competent internists. I disagree very distinctly with Dr. Gerber that we have no rationality for this treatment. We know and have known for years that the *x*-ray produces an atrophy in the cells of all secreting glands. The rate of this atrophy varies considerably with the glands, but if we can produce an atrophy in the cells of the gland, we will naturally decrease the secretion. In other words, we will remove part of the gland just as the surgeon removes mechanically a part of the gland. We have a better control. We can do it gradually and stop when the conditions

approach normal. I think we should never go to the point of reducing this secretion to normal, for a certain amount of atrophy will go on after we have stopped treatment. I have produced a hypothyroidism by *x*-ray treatment but under thyroid extract, the condition came back to normal, and the thyroid extract was discontinued. Therefore hypothyroidism is one of the dangers you should keep in mind. Outside of the treatment of fibroids of the uterus I know of nothing which has been so satisfactory.

Dr. Lichty referred to the malignant cases as not suitable for *x*-ray therapy. Frequently in the malignant cases the surgeon is unable to remove all of the disease, and if we know that the disease is malignant I think we ought to treat the case with the *x*-ray primarily; but the hard point is to diagnose between malignant and non-malignant, and so we should make the diagnosis at the time of operation. When the disease is found to be malignant use *x*-ray therapy and plenty of it. I have one case referred by Dr. Deaver who said, "I know I left malignant disease in there." The patient is still well eight years after treatment.

One other point: I think we ought to have Dr. Boggs give us his technique—a thing which is not settled any more than the selection of cases is settled. Briefly I do this—I am not sure it is the best: I generally treat these patients once a month, I count on keeping them under observation and treatment for at least a year with association with any additional medical treatment which has been found to be good, and the internist looks after that. I treat the patient. I try always to avoid producing an erythema, and I disagree with Dr. Gerber that it is criminal to get a tanning, these things are sometimes unavoidable, and we might be hailed into court as criminals. There are times when you cannot avoid it. These patients sometimes have sensitive skins, and we may get it. I say we should avoid it, but we must not go to the extent of calling it criminal. We must not treat the patient too long, because we may produce atrophy and telangiectases as an after-effect. For that reason all the associated causes of the disease must be removed so as to cut down the amount of treatment given. I treat the patient usually once in four weeks and increase that interval just as soon as the symptoms approach normal or get down to a working basis, and to me the pulse is the best guide. You get earliest an increase in weight and a decrease in nervous symptoms and a decrease in pulse, and the variation in the pulse rate between the recumbent and sitting posture is a pretty good guide as to the situation. When that variation is much greater than normal you have not reached the stage when you should stop treatment. I vary the number of doses according to the severity of the symptoms and that is not based on the size of the goiter. You treat them to decrease this secretion, not to diminish the size of the goiter, and when this is bad I give treatment through more fields. Generally I treat the patient through four fields or portals of entry and by cross-firing get results with the usual filters that are used in deep therapy and I generally give 5 milliamperes through 6 millimeters of aluminum at a distance of eight inches with a nine inch spark gap.

Dr. C. F. Ball.—There is one phase of the question which has been referred to only indirectly by Dr. Holmes in his remarks regarding basal metabolism. The final analysis of thyroid treatment sifts down to a study of the amino acids. I heard Dr. C. H. Mayo express it this way—that the thyroid was the fly-wheel of basal metabolism. We have twenty odd amino acids out of which the cells effect their development. Lysin is a sulphur containing amino acid which has to be present in every combination of amino acids making up a cell's construction. The thyroxin of the thyroid secretion determines the rate amino acids are used in a cell's construction. Increase in quantity of thyroxin causes increased amino-acid activity which is measured, as Dr. Holmes says, in basal metabolism studies.

Further it is a question of the study not of thyroid activity alone but of the entire endocrine circle. Not too much is known about it, but a final analysis on thyroid treatment, whether it be medical, surgical, or *x*-ray, has to resolve itself into a study of amino acids in their rôle of tissue cell metabolism. I want to approve what Dr. Pfahler has just said, on the basis of what I have just mentioned, that when you go after a thyroid gland, whatever portion you want to destroy, destroy it. Avoid a skin reaction as far as possible but operate to destroy that portion of gland being treated. You do not always have to destroy the whole gland. Destroy sufficient of the gland or at least inhibit the activity of the thyroid cells of a portion or all of the gland so that the pulse rate comes down and the weight increases. Nervous symptoms are really secondary and favorably obey the inhibiting influences of a reduced metabolic activity. The patient's slowing pulse rate and increase in weight should be the controlling

factors determining amount of *x*-ray irradiation necessary, and not nervous manifestations.

Dr. Charles A. Waters.—The material for my discussion will be a short review of a few experiments I have made rather than any destructive or constructive criticism of Dr. Lichty's and Dr. Boggs's papers.

It is a well-known fact that patients suffering from exophthalmic goiter and hyperthyroidism have periods of improvement due to no definite form of therapy. These patients oftentimes show considerable improvement even while attending to their daily tasks. Rest treatment alone produces the desired result in many cases without any definite form of medication, surgery, etc., so that the question to be considered, at least in my mind, is whether the improvement noted in these cases is due to the *x*-ray radiation or as a result of some other form of treatment. Therefore, it is of vital importance to know what action, if any, the *x*-ray has upon the thyroid gland in the different affections before one can state with any degree of certainty whether the improvement is due to the *x*-ray treatment.

The question of the rôle of the thymus gland in the production of hyperthyroidism is still a much debated question, as Dr. Lichty mentions. If it played a definite rôle in this disease, would it not be evident? Certainly from our series of cases of exophthalmic goiter at the Johns Hopkins Hospital (about 100) in which the thymus gland was intensively radiated, very little benefit could actually be laid to the result of the *x*-ray exposures to the thymus. Yet the thymus being so rich in lymphoid tissue, and because of the susceptibility of this type of disease to *x*-ray radiation, one would naturally suppose that immediate changes would be noted.

Reviewing the literature up to 1914, Ravé shows that the experimental work done on the thyroid gland with the *x*-ray reveals no histological changes in the gland. Of course, this work was carried out with the old type of gas *x*-ray tubes, short exposures and practically no filtration; as far as I know there has been no experimental work done with intensive Coolidge tube radiation and heavy filters.

Those of you who attended the Atlantic City meeting in January, 1917, may remember the hot discussions that took place in regard to this subject. I came away determined to find out what, if any, was the effect of Coolidge tube radiation on the thyroid gland.

In collaboration with Dr. Emil Goetsch we took five dogs, and at the suggestion of Dr. Halsted we removed a very small piece of gland from each thymus, before any treatment was started, for control sections. In other words, the particular gland receiving treatment would be controlled. Five dogs were worked on, but due to the sudden departure of the Hopkins Unit for France the work was never completed and the animals died in the Hunterian Laboratory and were never autopsied.

This spring we studied two more animals in the same way and although the material from which I quote is limited yet enough evidence, I believe, was obtained to warrant a much more thorough investigation of this work. I thought it might be of interest to tell briefly what our findings were from the results of the experiments on these two dogs.

Before attempting the treatment of exophthalmic goiter or hypothyroidism with *x*-rays it is vitally necessary (1) that it be known what histological change takes place in the gland; (2) that the superficial or deep structures of the skin and neck be not injured by the *x*-rays; (3) that the effect upon the vagus, sympathetic ganglion and parathyroids be definitely known; (4) that it be known what effect on the thyroid gland is desired, that is, stimulating or inhibiting. Therefore until these points are definitely proven the work is being done not only unscientifically but with extreme danger.

With these points in view we set about to determine whether any histological change was produced by the *x*-ray radiation and particularly if the secretory element of the gland, the mitochondria, was affected.

The histological sections were studied by Dr. Goetsch, and I will quote briefly from his notes:

The right glands were the ones exposed, while the left side of the neck was carefully protected with heavy lead foil. The dogs were etherized, two sections made of each gland, one stained with hematoxin and eosin and the other stained with acid fuchsin methyl green for mitochondria. The Coolidge tube technique used in the treatment of these animals was uniform and consisted of the following: 5 milliamperes; 9 inch spark gap; 4 mm. glass filter; 20 cm. focal distance. The durations of the treatments varied on certain days.

Dog B. I. Small brown fox terrier.

First *x*-ray treatment, June 17, 1919 10 min.

Second x-ray treatment, June 27, 1919 5 min.
Third x-ray treatment, July 7, 1919 5 min.
(At this time definite epilation of hair on the right side of neck was noticed.)
Fourth x-ray treatment, July 14, 1919 5 min.

Operation July 18, 1919. Very severe dermatitis was developing when the operation was undertaken. A small piece of gland was taken from the mid-portion of both lobes, the left lobe being used as a control.

Histological Notes of the Right Lobe (Treated Side)

Hematoxin Eosin Section

The striking feature is an easily recognized protoplasm and nuclear shrinkage. The alveolar epithelium is very much atrophied and thinned out and in places appearing as a mere line. The nuclei are small, pyknotic. The colloid is present and in slightly excess amounts over the normal. The appearance generally is that of a very atrophic and inactive gland resembling in many respects the familiar defect of the thyroid parenchyma in colloid goiter.

Left Lobe Control. Acid fuchsin methyl green section.—(This gland probably received some scattered radiation.) The histological picture is that closely resembling a normal dog's thyroid. Essential features are the following: The thyroid parenchyma is made up of cuboidal and lower columnar epithelium. There is a fairly rich amount of protoplasm in the cells but the nuclei are large, round and contain abundant chromatin enclosed about in granule formation. The protoplasm of the cells carries an abundance of bright red stained mitochondria in the form of granules and short rods. This picture would indicate that the cells are functioning normally or very nearly normally. (The extreme likelihood of this gland receiving a mild amount of exposure due to imperfect screening must be taken into consideration. Had this screening been more perfect that difference might have been more striking.) The colloid is present in moderate amount, as is found in the normal gland of the neck.

Right Lobe. Acid fuchsin methyl green section.—The entire technique (histological) is precisely the same as in the control gland. Here again is a striking change as seen in the hematoxin eosin section. The alveolar epithelium is very thin and atrophic; in places the protoplasm has almost vanished and it is in many places vacuolated. The nuclei are shrunken. The chromatin is smaller in amount and many of the nuclei are contracted and pyknotic. They stain faintly and poorly generally in the methyl green. The mitochondria are present here and there in very small numbers and they appear as mere shadows and stain poorly in acid fuchsin. In many areas they are not present at all. Colloid is moderately increased in amount. There is a very striking change seen in the thyroid lobe which has been exposed to the intense radiation and, summarizing, these changes consist of a striking atrophy and shrinkage of the thyroid parenchymal cells, both on the part of the protoplasm and nuclei. There is a moderate increase in the colloid and almost complete disappearance of mitochondria as compared with the control lobe which is very rich in mitochondria. From this appearance we have reason to think that there has been a marked reduction, if not very nearly complete absence, of secretory function in the cells of the thyroid gland as a direct result of the x-ray exposures.

Dog B. II. Medium brown terrier.

First treatment, June 18, 1919..... 3 min.
Second treatment, June 20, 1919..... 3 min.
Third treatment, June 24, 1919..... 3 min.
Fourth treatment, June 30, 1919..... 5 min.
Fifth treatment, July 10, 1919..... 5 min.
(No reaction or epilation notices up to this time but no more treatments were given until about three weeks)
Sixth treatment, July 30, 1919..... 5 min.

August 5th, epilation and beginning sloughing has started and operation was undertaken this date. Small section of the right and left glands were removed precisely as in Dog B. I.

Left Lobe Control. Acid fuchsin methyl green.—This control is analogous to the control gland in the first animal. The thyroid cells are rich in protoplasm, containing the usual numbers of mitochondria for a normal dog's glands. They are stained, however, somewhat fainter than in B. I. This is due probably to a more imperfect screening, the gland lying in this larger dog in a deeper level.

Right Lobe. Acid fuchsin methyl green section.—The findings here are much the same as in the treated lobe of Dog B. I. except that the process of atrophy and shrinkage of the protoplasm and nuclei has not progressed to such a striking degree as in B. I. This is accounted for, doubtless, by the fact that in this case we were treating a much larger dog in which the thyroid gland is more deeply situated and therefore more protected against

the action of the rays. (The doses were likewise not so heavy.) Mitochondria are present in some areas as mere shadows which are very faintly stained. In other areas they are hardly discernible at all. In general the difference in appearance in the normal and treated lobes is much as in the first case, though not to such a striking degree.

There is evidence of a power to reduce the function of the thyroid gland by *x*-ray radiation, as shown histologically, and doubtless part of the failures so far have been due to insufficient exposures. But is it possible to give large enough doses to produce this reduction in function without injuring the other vital structures in the neck? It is shown conclusively that with large enough amounts of radiation a reduction in the secretory apparatus can be effected; caution as to prognosis must be the watchword.

Dr. Willis F. Manges.—I would like to have Dr. Waters tell me how much treatment he gave the dogs.

Dr. Charles A. Waters.—Replying to the question of Dr. Manges in regard to the amount of treatment given the dogs, I might say that no attempt was made to regulate the amount of dosage except to be sure that the animal received a sufficient amount of therapy. The dose was a great deal more than one could give an individual.

Dr. John A. Lichty.—The discussion has certainly been very helpful to me. One of the men who discussed my paper spoke of the amino acids and referred to there being "only 20" of them. I heard Dr. Graham Lusk say several years ago that there were only 13 amino acids, six of which we understood! So our work is rapidly increasing and we have quite a task before us if we are going into amino acids, and yet we must approach the problem from all sides.

What amazes me as an internist is the way the thyroids are treated with apparently little consideration by a certain group of men who do not appear to know the effect of *x*-ray, or the effects of traumatism, such as surgery, upon an unbalanced thyroid. We have the same example in peptic ulcer; as soon as the diagnosis is made the operation is indicated. I see from the discussion what the attitude of ***this*** association is in this matter and I have no fears.

From Dr. Gerber's remarks I believe we may include *x*-ray treatment under medical treatment, and that is why I feel so comfortable about the discussions this morning. It is not necessary to handle the thyroid violently, except in those conditions where there is suffocation or when other emergencies occur.

As regards the question of medical treatment, Dr. Holmes said there is no medical treatment. There is no specific drug treatment, and yet there is a place for medical treatment in these cases.

I remember having a policeman in my service who came from a dry town in Ohio. He took his position seriously, and, with the many arrests he was compelled to make, he developed a hyperthyroid condition. The first thing he did after entering the hospital was to tell me about all the noises he heard from his room—the elevator running, the nurse walking, the door squeaking, etc. He asked when he would be well. I told him as soon as he did not hear these noises. While that was an easy thing to say, it was only after the proper administration of bromides that he heard the noises less and less frequently and thus hastened his recovery. There is no specific medication, but digitalis and the bromides are frequently needed. They should be used just as crutches are used in a case convalescing from a broken leg.

I am glad Dr. Pfahler called attention to focal infection. We are apt to run away with focal infection; however, I have no doubt focal infections are a factor, but unless we take focal infections at their face value, we are going to get into trouble. They must be considered from the standpoint of their own pathology and not merely with the hope of relieving obscure symptoms and bringing about far-reaching results.

I wish to thank this Association for giving me the pleasure of meeting with you. I am thinking of the time in 1896 when I was in Berlin, when an evening's entertainment was to go to a theatre and see some one hold a book up before the audience and show how the shadow of a key may be shown through the lids. This is not twenty-five years ago and yet in this short time *x*-ray has become such a factor in medicine as to bring a group of physicians together from all over this land to discuss its helpful and healing effects. We have only begun; the possibilities of *x*-ray are wonderful, and I do not believe surgeons will have "a look-in" in cases of hyperthyroidism if the advances your Association show continue.

THE EARLY ROENTGEN DIAGNOSIS OF ULCERATIVE TUBERCULOUS COLITIS*

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INTRODUCTION

THE diagnosis of intestinal tuberculosis has long puzzled many clinicians. Without doubt a positive diagnosis can be made with a considerable degree of assurance in well developed cases. On the other hand no one has yet determined when intestinal tuberculosis begins in the course of pulmonary tuberculosis. It might be recalled that at least in 60 to 80 per cent of cases of pulmonary tuberculosis coming to autopsy, intestinal tuberculosis is present. It is of further interest to note that in 85 per cent of cases of intestinal tuberculosis the ileocecal region is involved. Again, as gastrointestinal specialists and students of pulmonary tuberculosis hesitate in most instances to make a positive diagnosis of intestinal tuberculosis, it has seemed most important that some method should be devised that could determine an early diagnosis of the complication of pulmonary tuberculosis found most frequently at autopsy.

The first point that comes to mind when tuberculosis of the intestines is discussed is the presence of tubercle bacilli in the feces. It was long held that the occurrence of tubercle bacilli in the feces indicated intestinal tuberculosis. As early as 1891 Bodo[1] proved by a study of the intestinal content at autopsy that tubercle bacilli could be found in the feces when pulmonary but no intestinal tuberculosis was present. Occult blood may be found in some instances, but is lacking in some well developed cases. Without going further into details it can be stated that many observations have shown that the laboratory diagnosis of intestinal tuberculosis is as uncertain as the clinical diagnosis.

Symptoms recognized as characteristic of this condition occur usually only in such well marked cases that diagnosis of the condition is of little avail if remediable measures are to be applied. The study of this condition has emphasized that many slight subjective symptoms hitherto regarded as of little moment indicate now the necessity for a careful intestinal study. When, for instance, any patient with early pulmonary tuberculosis begins to do badly without increase of pulmonary signs or symptoms, or, what is more important, with their decrease, an intestinal examination should be made. We feel that slight anorexia, prolonged and marked, persistent meteorism, slight abdominal discomfort or actual pain, regurgitation or vomiting of food or even slight digestive disturbances, constipation or digehea, or alternating constipation and diarrhea, slight rise of temperature, often irregular, and not connected with increase of pulmonary symptoms, may give the first suggestion of beginning intestinal involvement. Again, any patient who fails to gain weight or to make satisfactory progress requires a roentgen study of his intestinal tract.

Some years ago from our study of artificial pneumothorax we came to the conclusion that the hopeless prognosis of intestinal tuberculosis might be due to the fact that it was impossible to give the bowel sufficient functional rest by medical measures to enable it to recover. With this point in mind we discussed the problem with Archibald[2] who began and later published (1917) the results of the surgical treatment of intestinal tuberculosis. In this article Pirie,[3] who at Archibald's suggestion, studied twelve of the twenty-six cases Archibald reported, states in a short paragraph that he was disappointed in not being able to visualize the barium meal in the cecum. By careful observations

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repeated at half hour intervals from the fourth to the twelfth hour, he showed that the cecum retained none of the barium which normally should have accumulated there. When our studies were nearly completed we discovered that Stierlin[4] of Basle had noted in six such cases the absence of barium or bismuth shadows at certain times and at certain sites when normally they should have been present. Upon this data, suggesting hypermotility, Stierlin diagnosed the presence of ulceration of the large bowel at the sites mentioned and later Wilms proved these conclusions correct at operation. He had also one case of chronic non-tuberculous ulceration.

TECHNIQUE

The technique, which varies little from that usually employed in roentgen laboratories must be carefully followed in certain details. We have thought best to describe the technique more minutely under two heads, (A) The Barium Meal, and (B) The Barium Enema.

A. THE BARIUM MEAL.—The barium meal that we have used consists of four ounces of barium sulphate, one tablespoonful each of flour, cocoa and sugar; milk (sweet) to make sixteen ounces or two glasses.

The day before the patient reports at the roentgen laboratory he takes no laxative. On the morning of examination, prior to the ingestion of the barium meal, the patient is permitted to have breakfast. The barium meal is taken at an appointed time, usually about 9 A.M. The ingestion of the meal need not be observed fluoroscopically, as in none of the cases has the observation of the ingestion of the meal proved of any value.

1. *Fluoroscopic Examination.*—Six hours after the ingestion of the barium meal the patient reports for examination, having abstained from food in the meantime. Note is made at this time of any barium remaining in the stomach, the quantity of barium seen in the ileum and the character of the small bowel shadows. Particular attention is paid to the position of the head of the column, the degree of filling of the ascending colon and the outline of this portion of the bowel. At this hour the cecum and probably also the ascending colon should be well filled. However, slight variations from this hard and fast rule may be observed and are probably normal manifestations. If none of the meal has entered the cecum it is apparent at once that no pathological changes in the cecum can be definitely interpreted. In this case the patient must be observed fluoroscopically at intervals of one-half to one hour until the barium is seen within or beyond the ascending colon. This may require watching the patient from the sixth to the ninth hour.

If, on the other hand, the head of the column is well past the splenic flexure, and little or no barium remains proximal to the ileocecal sphincter, it is readily seen that the meal under observation will probably never fill the cecum. We have seen but one such case. If the head of the column is well past the splenic flexure and the cecum or ascending colon is empty and barium still present proximal to the ileocecal sphincter, the case must be observed at the short intervals previously mentioned in order to observe the character of the shadows of the cecum and ascending colon.

If a definite filling defect of the cecum or ascending colon is observed when a quantity of barium sufficient to fill them has been delivered to or has gone past these portions of the colon, there can be little question of a pathological filling defect; but even here it is advisable to re-examine the patient after one or two intervals.

We can summarize these observations under four heads: (1) The barium has not yet reached the cecum; (2) an insufficient quantity of barium has reached the cecum; (3) sufficient barium has reached and passed the cecum; and (4) practically all of the barium has passed the cecum.

Following the six hour examination, as we have said, the patient is fluoroscoped at given intervals, in any case at seven and

eight hours, in order to confirm definitely the less positive of the above findings. However, the classical changes, i.e., a definite filling defect or a ragged appearance of the cecum or of the ascending colon, plus the advanced position of the head of the column, apparently make the seven and eight hour examinations unnecessary.

The following morning, or twenty-four hours after the ingestion of the meal, the patient again reports for examination, and note is made of the barium shadows that may be present, paying close attention to the region of the ascending colon. However, the bowel is usually completely empty. At times the examination at twelve and eighteen hours will give additional information, and these may make the twenty-four hour examination unnecessary. Two or three days later the patient is examined during and following the administration of a barium enema.

II. *Radiological Examination.* Plates are taken at all examinations, usually in the prone position.

B. THE BARIUM ENEMA.—The enema we have used consists of the following: Mix dry in a large bowl six ounces of gum arabic and ten ounces of barium sulphate. Add to this rapidly, stirring vigorously, forty-five ounces of hot water.

The patient reports at 10 or 11 A.M. for a barium enema. At 1 or 2 P.M. on the previous day (i.e., twenty or twenty-two hours before the enema) he has taken an ounce of castor oil. He abstains from supper, but a light breakfast is permitted on the day of the examination. A small quantity of barium (1 dram to ½ oz.) may be given with the meal just preceding the castor oil in order to detect whether any of this meal is present in the colon at the time of the barium enema. The enemas are administered in the prone or supine position. As little gravity pressure as possible is used to keep the injection moving (usually 10 to 24 inches).

I. *The Fluoroscopic Examination.*—The administration of the enema is observed fluoroscopically, note being made as to the outline of the bowel and as to the manner in which it fills. Any other unusual features attending the injection are also observed and plated. The patients may be examined in any position that will give the desired information. However, the prone and supine appear usually sufficient. During the administration the patient may complain of discomfort, or even of a sense of pain at times, which is usually only temporary. When the enema is seen to have reached the cecum, or, as in many instances, has passed through the ileocecal sphincter, the flow is shut off.

II. *The Radiographic Examination.*—At all examinations plates are made, usually in the prone position.

NORMAL MOTILITY AND CONTOUR.—Before describing the various roentgen manifestations observed in patients suffering from tuberculous colitis, it seems advisable to consider roentgenographically a few points of the normal physiology and anatomy of the gastrointestinal tract. Following the ingestion of a standard barium meal the stomach usually empties itself in from three to six hours. The first evidence of barium is seen at the ileocecal sphincter in from one to three hours. The ileum empties itself in from five to nine hours. Barium is first seen in the cecum in from two to four hours, which gradually fills as it receives the intestinal contents from the ileum. In the meantime the barium column moves slowly forward until all the barium is in the colon. Six hours after the ingestion of the meal the head of the barium column is seen in the colon, usually proximal to the splenic flexure. At this hour the cecum and ascending colon are well filled and the haustra are distinctly seen. The ascending colon remains well filled from the fourth to the fourteenth hour following ingestion, and in many cases as long as thirty-six hours. Complete evacuation takes place usually in from thirty to forty-eight hours.

PATHOLOGICAL HYPERMOTILITY.—The first manifestation that attracted our

attention in many of the cases that were later proved to have tuberculous colitis was that in twenty to twenty-four hours the barium had been completely eliminated. This hypermotility was usually found only in those cases that had the most suggestive clinical picture. Thinking that this hypermotility might be the result of an existing tuberculosis somewhere in the intestinal tract an effort was made to determine its location. At first it was thought that this hypermotility might be the result of the influence of a laxative. However, in the succeeding cases patients were instructed to abstain from any laxatives for at least thirty-six hours prior to the roentgen examination. It may be mentioned here, however, that only a few of the positive and doubtful cases used laxatives or oils, as their bowels were usually loose. Upon re-examining some of the earlier cases who previously may have taken laxatives it was noted that there still existed a definite hypermotility.

Close attention was paid to the different parts of the small and large intestine with regard to the physiology and anatomy of the respective parts, with the result that the cecum and ascending colon fell under suspicion. Examining patients at short intervals from the sixth to the eighth hour, it was noticed that the cecum and possibly the ascending colon, and in some cases other portions of the colon distal to these sites, refused to retain barium to their full capacity, that is to say, they showed a greater tendency to discharge barium than to retain it any length of time. In many instances, in fact, so little

FIG. 1. CASE 7348. SIX HOURS, PRONE.

Note ileal stasis; no barium shadows have reached cecum. Referred for pulmonary tuberculosis, far advanced. Definite symptoms of intestinal tuberculosis. Site of *x*-ray lesion, diagnosis of tuberculous colitis (site not determined) made on ileal stasis at six hours plus practically complete absence of barium shadows at twenty-four hours. At operation, ascending and transverse colon tuberculous. Operation, excision of diseased area. Post-operative death.

FIG. 2. SAME CASE AS FIG. 1. 24 HOURS, PRONE.

Hypermotility, only faint traces of barium remain.

barium was seen in the cecum or ascending colon at different examinations that it was not possible to visualize a well-filled cecum or ascending colon. The character of the shadows in these portions of the bowel was so irregular at all times that we inferred that these portions of the colon were, more or less continually, in a state of spasm or collapse, and as soon as material was delivered to these portions, it was largely or completely eliminated. Consequently it was impossible to catch these portions of the colon well filled. In other cases different manifestations existed. At six or seven hours, instead of seeing the cecum filled, no barium had passed the ileocecal sphincter, even though the stomach was entirely empty. All the meal was seen in the terminal ileum. A subsequent examination, one hour later, might reveal the head of the column distal to the middle of the transverse colon with still nothing in the cecum or ascending colon, and at twenty-four hours the bowel would be either entirely empty or the entire meal found in the sigmoid and rectum. An illustrative case can be seen in Fig. 1. Six and seven hour examination, stomach empty, head of the column at the ileocecal sphincter. Twenty-four hours, all barium has been eliminated. It is quite possible that the ascending colon did contain barium for a longer or shorter period of time, some time between the sixth and twenty-fourth hour. However, certain cases

FIG. 3. CASE 7162. SIX HOURS, PRONE.

Note spastic ragged appearance to cecum and ceco-colon. Hypermotility, head of column in rectum. Referred for pulmonary tuberculosis. Hyperacidity, occasional vomiting, frequent regurgitation of food, marked constipation. Cecum palpable, possibly thickened. Site of *x*-ray lesion, cecum and ceco-colon, indicated by lines. At operation cecum and ceco-colon tuberculous. Operation, excision of diseased area. Condition one year after operation, apparently complete recovery.

FIG. 4. CASE 7213. SIX HOURS, PRONE.

Spastic, ragged appearance of ascending and first portion of transverse bowel. Hypermotility; head of the column in sigmoid. Referred for pulmonary tuberculosis. Occasional diarrhea, stools foul, slight abdominal discomfort. Site of *x*-ray lesion, ascending and probably first portion of transverse colon (indicated by lines). At operation ascending and first half of transverse colon tuberculous. Operation, appendectomy. Condition twelve months after operation, no symptoms, gain of thirty pounds. Twenty-four hour examination, bowel entirely empty.

revealed no appreciable amount of barium, at least in the cecum, at the times when they were examined.

Another class of cases presented slight variations from the course described above. At six hours the head of the column was in the sigmoid or rectum, with the large bowel well filled from this point as far back as the suspected portion, in which there might be little or no barium. The ileum was usually fairly well filled. (See Fig. 4.) Re-examination of these patients at short intervals would reveal the ileum emptying or emptied. However, no barium remained in the cecum or ascending colon, the areas which were under suspicion.

In some cases while palpating the abdomen in the region of the ascending colon, in an effort to fill this portion of the bowel, which may have been only partially filled, we were decidedly unsuccessful, and were surprised to find what little barium may have been in the cecum move forward rather rapidly to some distal portion of the colon. The *vis-a-tergo* could apparently be excluded.

Some of the cases examined earlier in the series were brought back for complete re-examination to see if the various pathological manifestations could again be observed. All of the cases which were regarded as positive at the first examination were confirmed at subsequent examinations.

FIG. 5. CASE 7588. SIX HOURS, PRONE.

Note filling defect of ascending and first portion of transverse colon. Referred for pulmonary tuberculosis, moderately advanced. Definite abdominal symptoms with pain. Site of *x*-ray lesion ascending and first portion of transverse colon. At operation ascending and first half of transverse colon tuberculous. Twenty-four hour plate, bowel entirely empty.

FIG. 6. SAME CASE AS FIG. 5. ENEMA PLATE, PRONE.

Note filling defect of ascending and first portion of transverse colon.

FILLING DEFECTS.—Since the cecum or ascending colon was apparently the site of the tuberculous focus, and recalling the physiology of these portions of the bowel, it seemed as though some importance could be attached to the phenomena observed at these sites. Normally these portions of the bowel accept and retain

for varying lengths of time considerable fecal matter, which usually fills them and reveals their smooth contour. In cases with tuberculous colitis, proved at operation, smooth haustration was absent and the bowel had a distinctly ragged outline. A description of the filling defect is difficult, and the reader is referred to Figs. 8, 3, and 5 as good illustrations of this manifestation. At different examinations between the fifth and ninth hour this filling defect would vary, but was always present.

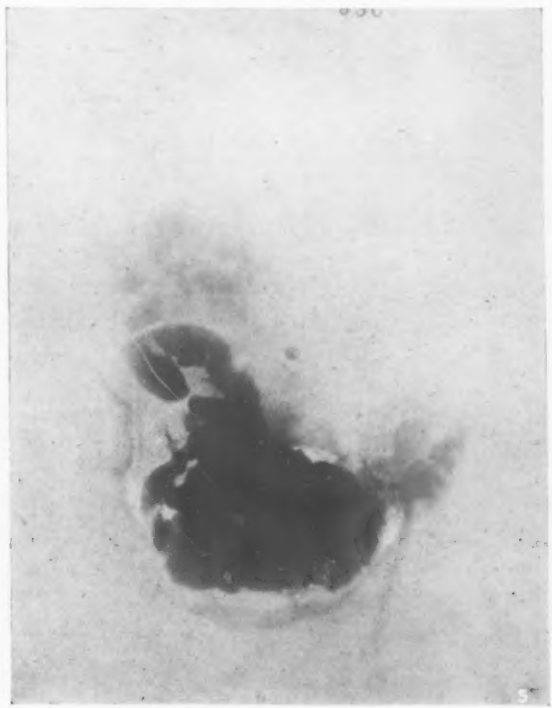

FIG. 7. CASE 9307. SIX HOURS, PRONE.

Spastic, ragged appearance to ascending and probably a portion of the transverse colon. Hypermotility, head of column in the rectum. Referred for pulmonary tuberculosis. Definite abdominal symptoms with diarrhea and pain. Site of *x*-ray lesion, ascending colon and probably portion of transverse (indicated by lines). At twenty-four hours, bowel entirely empty.

FIG. 8. CASE 5135. SIX HOURS, PRONE.

Note filling defect (spasm) in cecal region. Patient referred for pulmonary tuberculosis. Abdominal symptoms, constipation. Site of *x*-ray lesion, cecum and ceco-colon. Twenty-four hour examination revealed bowel empty as far as rectum.

The question arose immediately, could other conditions produce this combination, i.e., hypermotility and filling defect, and their peculiar accompanying features? A few cases were observed that had taken laxatives (usually castor oil) the night before the barium meal was given. Particular attention was paid to the cecal region and the variation in the motility of the bowel, and while the latter was increased perceptibly (in some instances the bowel was empty in twenty-four hours), the spastic or ragged outline of the ascending colon did not occur. This portion of the bowel may have been incompletely filled at different examinations, but the outline of the haustra was usually fairly smooth. The most notable feature in these cases was the tendency of the proximal portions of the colon, particularly the ascending colon, to retain barium a reasonable length of time. This, apparently, is just the contrary of what occurs in patients having tuberculous colitis.

A few cases of acute and habitual diarrhea were examined, but in none were there any definite filling defects. There was

a rapid emptying of the bowel, however; in some cases complete emptying occurred in less than twenty-four hours.

On going over the literature we found an article by Jordan[5] in which he studied the motility of the bowel in various conditions. He describes and illustrates in this article a number of cases of colitis and diarrhea, but in none of these were we able to see the manifestations we had observed in cases suffering from tuberculous colitis. His illustrations reveal the cecum usually well filled and with smooth haustrations even though in a number of instances there was definite history of diarrhea. Such findings taken together with the cases suffering from habitual diarrhea that we have observed made us feel reasonably sure that the cecum or ascending colon did not present in these conditions the picture seen in tuberculous colitis. Other articles by Imboden[6] and Spriggs,[7] illustrate the findings in many cases of chronic appendicitis, and here again we failed to find the picture we have described. In fact, in practically all the illustrations shown the cecum was invariably well filled. A review of George and Leonard's[8] book also helped to confirm the standards laid down for tuberculous colitis.

Study of the Barium Enema.—The enema is seen to move slowly cecalward, usually in an unbroken column, until it reaches the diseased portion of the colon, where it may be held up temporarily. At other times gas in the bowel interferes with its progress. At this time a slight increase of gravity pressure or mild manipulation will usually overcome the obstruction. When the barium entered the diseased portions of the colon, certain manifestations were observed similar to those seen following

FIG. 9. SAME CASE AS FIG. 8. ENEMA PLATE, PRONE.

Note filling defect in cecum and ceco-colon. Repeated spasm of this portion of the bowel was observed following injection of enema.

FIG. 10. SAME CASE AS FIG. 8. SECOND EXAMINATION, ONE MONTH LATER. FOUR HOURS, PRONE.

Note filling defect in ascending colon region, particularly the cecum.

the ingestion of a meal. The enema filled the diseased portion (usually the cecum and ascending colon) very slowly and in many instances in a very irregular fashion. It seemed in many of the cases that these portions of the bowel were in a state of spasm or collapse and that the enema found difficulty in gaining entrance. However, it would eventually fill them, only to be forced out a few seconds later by a spasm of this portion of the colon. This sequence of events, filling and emptying, might be repeated often in the next few minutes. In all of the cases manifesting the above features, which came to operation, cecal ulceration (tuberculous) was found. However, in one or two of the cases in which the bowel was completely filled, tuberculous colitis was present. It is difficult, therefore, to place a definite value on the spasm which at times follows the injection of the enema. We are at present studying a number of normal cases to note if such a spasm occurs. The presence of a spasm seems in diagnosis to be of more value than its absence.

ANALYSIS OF RESULTS

In all, 175 cases have been examined roentgenologically. Of these 44 were positive, 32 doubtful, and 99 negative for tuberculous colitis.

PULMONARY TUBERCULOSIS

		Operated upon
Positive Cases, 44		
Incipient	4	2
Moderately adv	19	4
Far advanced	21	8
Doubtful Cases, 32		
Incipient	3	0
Mod. advanced	22	1[a]
Far advanced	7	0
Negative Cases, 99		
Neg. or Doubtful	12	0
Incipient	15	0
Mod. advanced	70	0
Far advanced	2	1[b]
Total	175	16

About fifty cases have been examined for other physicians, and of these twelve have been operated on and are included in the following table, through the kindness of Doctors R. C. Paterson, R. M. Brown, S. F. Blanchet and C. C. Trembley:

PULMONARY TUBERCULOSIS
CASES OPERATED UPON, 28

	Operative Findings		
	Positive	Negative	
Positive by x-ray, 22			
Incipient	2	2	.....
Moderately advanced	12	12	.....
Far advanced	8	8	.....
Doubtful by x-ray, 5			
Moderately advanced	4	3	1[a]
Far advanced	1	1	.....
Negative by x-ray, 1			
Far advanced	1	.....	1[b]
Total	28	26	2

On comparing the operative findings with the roentgenological interpretation it was found that many of the foregoing cases presented more extensive ulceration than was indicated by the plate or fluoroscope. However, in the remainder of the cases the changes found at operation tallied very closely with what was suspected at the roentgenological examination. The reason for this discrepancy in operative and plate findings is probably due to the fact that those portions of the bowel distal to the middle of the transverse colon could not be studied with any degree of certainty at the six and twenty-four hour examinations. After fecal matter had passed, say, the hepatic flexure, it was likely to remain such a short length of time in any portion of the bowel distal to this site that it was impossible to interpret any definite hypermotility or filling defect. Again, bearing in mind the physiology of these portions of the bowel, particularly those distal to the middle of the transverse colon, it can be readily understood that it might be impossible to get any roentgenological evidence suggesting lesions in these parts. However, examinations at other times, between the sixth and twenty-fourth hour, might give us some information on this point. Force of circumstances did not permit us to do this in many instances.

The question of diagnosis of tuberculous enteritis has been purposely omitted from this article, and as far as we are aware no

a. This case presented a filling defect in the transverse colon and some hypermotility, which emphasizes the danger of interpreting filling defects beyond the hepatic flexure.

b. We believed that this patient had tuberculous enteritis, and at operation this was found, while the colon was normal.

work has been done that establishes definitely the diagnosis of tuberculosis of the small intestine. However, consideration should always be given to this portion of the bowel if operative measures are to be suggested. At present we have the question of the diagnosis of tuberculosis of the small intestine in mind and are working upon it.

A number of cases in the preceding tables have been classified as "doubtful," which, from the clinical side, presented all the symptoms of intestinal tuberculosis and were unlike those cases that were classified as "positive." The reason for classifying these cases roentgenologically as "doubtful" is based upon the fairly marked changes in the proximal portions of the large bowel, particularly the cecum and ceco-colon. At some of the examinations the cecum and ceco-colon did not present the usual pouchlike appearance expected. The width of the bowel shadow at these sites was narrower than normally seen and the margins of the shadows were somewhat ragged. At twenty-four hours in these cases a fairly definite hypermotility might have been observed. At different times between the six and nine hour examinations this ragged appearance of the cecum persisted. However, typical spasm as observed in the positive cases was never seen. Had we examined these patients at other times the spasm or filling defect might have been present. Possibly the most characteristic or suggestive finding in these cases was the lack of smooth haustration usually seen in normal individuals. Some of these cases revealed a distinctly narrowed appearance to a small portion of the bowel, usually the cecum, which normally is found to have a greater width than portions distal to it. Following the injection of an enema this narrowing persisted. Some of these cases have been operated upon and have been found to be

FIG. 11. SAME CASE AS FIG. 8. SECOND EXAMINATION. FIVE HOURS, PRONE.

Note persistent filling defect in ascending colon.

FIG. 12. SAME CASE AS FIG. 8. SECOND EXAMINATION. SIX HOURS PRONE.

Note persistent filling defect in ascending colon. Twenty-four hour plate; bowel entirely empty.

tuberculous. The site of the ulceration commonly agreed with the atypical filling defect of the cecum or ascending colon. We would like to state that the absence of a definite hypermotility and filling defect or spasm does not necessarily indicate the absence of a tuberculous colitis. The presence of a beginning hypertrophic colonic tuberculosis may cause not only a lack of emptying, but even a retention at the end of twenty-four hours.

CONCLUSIONS

1. Tuberculous colitis may be diagnosed positively, clinically, in many well advanced cases.

2. In many early cases a positive diagnosis by clinical or laboratory methods cannot be made.

3. This roentgenological method has enabled a diagnosis to be made positively in many cases where otherwise it would have remained uncertain.

4. The roentgenological diagnostic criteria are filling defects and hypermotility.

5. Emphasis must be placed on the fluoroscopic examination, but some plates must be taken in each case to reveal and to record certain filling defects.

POSITIVE CASES

Case	Pulmonary Disease: Pulmonary Condition	Pulmonary Disease: Roentgen Classification	Pulmonary Disease: Tubercle Bacilli	Pulmonary Disease: Duration of Illness in Months	Tuberculous Complications	General Condition	Six Hour Examination Barium Shadows: Il	Ce	HF	TC	DC	R	Spasm	Twenty-Four Hour Examination Barium Shadows: Ce	HF	TC	DC	R	Filling Defect Enema Plate	Abdominal Symptoms
4909	FA	3	+	36	.....	Fav.	+	Sl	..	..	..	..	Cecum	o	o	o	+	+	.....	2, 5,
5045	FA	3	+	40	.....	Fav.	+	Sl	..	..	..	..	Cecum	o	o	o	o	o	Ce-HF	7
6867	FA	..	+	60	.....	Fav.	o	Sl	+	+	+	..	Cecum	No	Exa	min	atio	n		
7162	I	2	o	3	.....	Unfav.	o	Sl	+	+	+	..	Cecum	Sl	Sl	Sl	Sl	Sl	.....	3, 5, 6, 7, 8
7348	FA	3	+	30	.....	Unfav.	+	..	..	..	..	..	.....	o	o	o	Sl	Sl	.....	2 and 5 questionable 7 and 8 persistent
7366	FA	..	+	36	Nephritis	Unfav.	+	Sl	..	..	..	..	Cecum	No	Exa	min	atio	n		2, 3, 5, 7, 8 persistent
7514	FA	..	+	14	.....	Unfav.	+	Sl	+	+	+	..	Cecum	o	o	o	Sl	+	.....	3 severe, 7
7521	MA	3	+	24	.....	Fav.	+	Sl	+	+	+	..	Cecum	o	o	o	o	o	Ce?	1, 3, 6
7541	FA	..	+	8	.....	Unfav.	+	+	o	+	+	..	HF	o	o	o	o	Sl	.....	1, 3, 4, 6, 7
7561	MA	..	..	12	Larynx	Unfav.	+	Sl	+	+	+	..	Cecum	o	o	o	o	o	o	1 persistent
7607	FA	..	+	13	.....	Unfav.	Sl	+	o	o	o	+	Ce-TC	o	o	o	o	+	.....	1, 4
7724	FA	..	+	6	Elbow	Unfav.	+	+	+	o	o	+	TC	o	o	o	o	o	o	3, 5, 8, 1 and 7 persistent
7739	MA	3	+	10	.....	Fav.	+	?	..	..	..	..	Ce?	o	o	o	o	+	o	1 and 6 alternately
7805	MA	..	+	14	.....	Unfav.	+	Sl	o	o	o	S	Ce	o	o	o	o	+	.....	2, 3, 4, 5, 8
7806	I	3	+	24	.....	Fav.	+	+	o	o	+	..	Ce	o	Sl	o	o	+	o	1, 4, 7
7822	MA	..	o	18	.....	Unfav.	+	Sl	..	..	..	..	Ce	o	o	o	+	+	Ce	1, 2, 5, 3 severe
7875	FA	..	+	9	.....	Unfav.	+	..	..	..	..	..	.....	o	o	o	o	o	.....	1, 3
7901	FA	3	+	36	.....	Unfav.	+	Sl	..	..	..	..	Ce	o	o	o	o	o	Ce	1
5075	MA	2	+	9	.....	Fav.	+	+	+	+	+	-	Ce	Sl	Sl	o	o	Sl	Ce	1
8544	FA	3	+	6	Larynx	Unfav.	12	Ho	ur	Exa	m.		.....	o	o	o	o	+	Ce ?	6, 7
8593	MA	3	-	12	.....	Unfav.	+	+	..	..	..	..	Ce	+	+	o	o	+	.....	1, 3, 8, -7 severe
8873	I	3	-	14	Appendectomy	Fav.	+	+	S	S	+	..	Ce	o	o	o	o	+	Ce ?	1, 2, 3, 7, 8
7093	FA	3	+	36	.....	Fav.	+	+	+	+	+	..	Ce-TC	o	o	o	o	..	Ce-TC	1 and 6 alternately
7733	FA	3	+	36	Larynx, ear rectal abscess	Unfav.	+	S	..	..	..	..	Ce	o	o	o	o	o	.....	1, 3, 4, 8
8985	MA	..	+	12	.....	Fav.	+	..	..	..	..	..	Ce	Sl	+	..	..	..	.....	3, 6, 8
5058	MA	3	+	10	.....	Fav.	+	+	+	+	+	..	Ce	o	o	o	o	o	Ce	1, 2, 3, 4, 8
9307	FA	3	+	..	.....	Fav.	+	o	+	o	+	+	Ce	o	o	o	o	o	.....	1, 4, -7 marked
5096	FA	3	+	7	.....	Fav.	o	o	o	o	+	+	.....	o	o	o	o	o	Ce ?	1, 2, 4, 8
4876	FA	3	+	5½	.....	Fav.	+	+	+	+	..	..	Ce	Sl	+	+	+	+	.....	4, 7
9508	FA	3	+	..	.....	Fav.	+	Sl	o	Sl	Sl	+	Ce-HF	o	o	o	o	o	.....	1, 2, 3, 5, 7
4428	MA	3	+	37	.....	Unfav.	+	o	+	+	..	..	Ce ?	o	o	+	+	o	.....	1, 2, 3, 4
5135	MA	3	+	6	.....	Fav.	+	Sl	+	+	..	..	Ce	o	o	o	o	+	Ce	6
9561	MA	3	+	19	Isch.–rectal abscess	Fav.	+	+	+	+	+	+	Ce-HF	o	o	o	o	+	.....	1, 7
5178	MA	3	o	18	Isch.–rectal abcess	Fav.	+	Sl	Sl	o	+	+	Ce	o	o	o	o	+	.....	6
5143	I	3	+	7	.....	Fav.	+	o	o	o	o	Sl	Ce	o	o	o	o	+	Ce	4, 6
9676	FA	..	+	31	.....	Fav.	+	..	..	..	..	..	.....	o	o	o	o	+	.....	2, 3, 8, 1 and 6 alternately
9701	FA	3	+	10	.....	Fav.	+	+	+	+	+	..	Ce	o	o	o	o	o	.....	1, 2, 3, 4, 5, 7, 8
5200	MA	3	+	6	.....	Fav.	+	o	Sl	..	..	..	Ce	o	o	o	o	o	.....	
5070	MA	3	+	8	.....	Fav.	+	+	+	+	+	+	Ce	o	o	o	o	+	.....	4
9890	MA	3	+	22	.....	Fav.	+	+	+	+	+	..	Ce	o	o	o	o	o	.....	1, 3, 4, 8
9907	MA	3	+	120	.....	Fav.	+	Sl	Sl	+	+	+	Ce-HF	o	o	o	o	+	.....	1, 8
10090	MA	3	+	14	.....	Fav.	+	Sl	o	o	o	+	Ce	o	o	o	o	o	.....	1, 2, 3, 7, 8
10092	FA	..	+	9	.....	Fav.	+	Sl	+	+	+	+	Ce	o	o	o	o	o	.....	2, 3, 8
10170	MA	..	+	6	Isch.–rectal abscess	Fav.	+	Sl	Sl	o	+	..	Ce-HF	o	o	o	o	o	.....	1, 2, 5, 7, 8

DOUBTFUL CASES

Case	Pulmonary Disease: Pulmonary Condition	Pulmonary Disease: Roentgen Classification	Pulmonary Disease: Tubercle Bacilli	Pulmonary Disease: Duration of Illness in Months	Tuberculous Complications	General Condition	Six Hour Examination Barium Shadows: Il	Ce	HF	TC	DC	R	Spasm	Twenty-Four Hour Examination Barium Shadows: Ce	HF	TC	DC	R	Filling Defect Enema Plate	Abdominal Symptoms
4775	MA	3	+	30	.....	Fav.	+	+	+	..	..	..	.....	o	o	o	o	+	.....	1, 2, 3, 4, 5
4780	MA	3	+	54	.....	Fav.	+	+	+	..	..	..	.....	o	o	o	o	o	.....	6
4815	I	1	o	42	.....	Fav.	+	+	+	+	..	..	Ce ?	o	o	o	+	+	.....	4, 7
4881	MA	3	+	30	.....	Fav.	+	+	+	..	..	..	.....	+	+	+	+	+	Cecum	2, 3, 4, 6, 8
4902	MA	2	+	3	.....	Fav.	+	+	+	+	..	..	Ce ?	Sl	Sl	Sl	Sl	+	.....	2, 4, 5, 7
4908	MA	2	o	7	.....	Fav.	+	+	+	+	+	+	.....	o	o	o	+	+	.....	2, 3, 4
4948	MA	Pb	o	36	.....	Unfav.	+	+	+	..	..	..	.....	o	o	o	o	+	.....	2, 4
4955	MA	2	+	2	.....	Fav.	+	+	..	..	..	..	.....	o	o	o	o	+	.....	4, 6
5000	MA	3	+	24	.....	Fav.	+	+	+	+	..	..	.....	o	o	o	o	+	.....	4, 6, 7
7522	FA	..	+	36	Larynx	Unfav.	+	+	+	+	..	..	Ce ?	o	o	o	Sl	+	.....	1 and 6 alternately
7529	FA	3	..	60	Appendectomy	Unfav.	+	Sl	Sl	..	..	..	Ce ?	Sl	o	o	+	+	.....	1, 3, 4, 7, 8
7722	MA	3	+	18	Larynx	Fav.	+	+	+	+	..	..	.....	o	o	+	o	+	o	1
7863	MA	..	+	24	Larynx	Fav.	+	Sl	o	o	+	..	.....	+	+	+	o	Sl	.....	
7877	FA	3	+	9	Larynx	Unfav.	+	..	..	..	..	..	.....	+	+	+	..	..	.....	
8563	MA	3	+	42	.....	Fav.	12	Ho	ur	Ex	am.		Ce ?	+	+	+	o	+	o	1
4544	MA	Pb	+	10	Larynx	Fav.	o	+	+	+	..	..	Ce ?	Sl	+	+	+	+	.....	1, 3, 4
8042	MA	3	+	12	Otitis Med.	.....	+	+	+	+	Sl	..	.....	o	o	+	o	Sl	.....	8
9206	MA	3	+	18	.....	Fav.	+	+	+	+	..	..	Ce ?	o	+	+	+	o	.....	6, 8
7493	FA	3	+	20	Larynx	Fav.	+	Sl	..	..	..	..	.....	Sl	Sl	o	Sl	Sl	.....	2, 3, 8
7923	MA	3	+	48	Nephritis	Fav.	+	+	+	+	+	..	.....	Sl	+	+	o	o	Cecum	1 and 6 alternately 1, 3, 7, -8 marked
5080	I	2	+	16	.....	Unfav.	+	+	+	+	+	..	.....	o	o	o	o	o	.....	1, 2, 3, 8
4989	MA	3	+	115	.....	Fav.	+	+	o	+	..	..	Ce?	o	o	+	+	+	.....	4, 6
8076	I	o	2	22	.....	Fav.	+	+	+	..	..	..	Ce ?	+	+	+	+	+	.....	3, 7
5046	FA	3	+	30	.....	Fav.	+	..	..	..	..	..	.....	+	+	+	+	+	Ce ?	2, 6, 8
9532	MA	3	+	180	.....	Fav.	+	+	+	+	..	..	Ce ?	Sl	Sl	Sl	Sl	+	.....	
9602	MA	3	..	13	.....	Fav.	+	Sl	Sl	Sl	..	..	Ce ?	o	o	o	o	Sl	.....	3, 4, 7
5159	MA	3	+	4	.....	Fav.	+	o	+	+	..	..	Ce ?	o	o	o	o	+	.....	
9776	MA	3	o	17	.....	Fav.	+	+	+	+	..	..	Ce ?	o	o	o	o	+	.....	1, 7, 8
5307	FA	3	+	16	.....	Fav.	+	+	+	..	..	..	Ce ?	o	o	o	+	+	Ce	
5165	MA	2	+	12	.....	Unfav.	+	+	+	+	+	+	Ce ?	o	o	o	o	+	.....	4
10126	FA	..	+	38	.....	Fav.	+	..	..	..	..	..	.....	+	+	+	+	+	.....	6
9315	FA	3	+	24	.....	Fav.	+	+	..	..	..	..	TC ?	+	+	+	+	+	.....	

NEGATIVE CASES

Case	Pulmonary Disease: Pulmonary Condition	Pulmonary Disease: Roentgen Classification	Pulmonary Disease: Tubercle Bacilli	Pulmonary Disease: Duration of Illness in Months	Tuberculous Complications	General Condition	Six Hour Examination Barium Shadows: Il	Ce	HF	TC	DC	R	Spasm	Twenty-Four Hour Examination Barium Shadows: Ce	HF	TC	DC	R	Filling Defect Enema Plate	Abdominal Symptoms
4716	MA	1	+	18	.....	Fav.	+	+	+	..	..	..	o	+	+	+	+	..	.....	4
4743	MA	Pb	+	21	.....	Unfav.	+	+	+	..	..	..	o	+	+	+	+	..	.....	2, 5, 6, 7, 8
4768	MA	1	o	13	.....	Fav.	+	+	+	+	..	..	o	+	+	+	+	..	.....	2, 4, 5, 6, 7
4773	MA	1	-	8½	.....	Fav.	+	+	+	..	..	..	o	+	+	+	+	..	.....	2, 4, 6, 7
4774	MA	Pb	-	48	.....	Fav.	+	+	+	..	..	..	o	+	+	+	+	..	.....	2, 5, 6, 7
4777	MA	Pb	+	42	.....	Fav.	+	+	+	..	..	..	o	+	+	+	+	..	.....	1, 3, 4
4785	MA	Pb	-	8	.....	Fav.	+	+	+	..	..	..	o	+	+	+	+	..	.....	6
4787	D	Pb	o	18	.....	Fav.	+	+	+	..	..	..	o	+	+	+	+	+	.....	1, 2, 4, 5, 7
4803	MA	1	-	10	.....	Fav.	+	+	+	..	..	..	o	+	+	+	+	..	.....	4, 6
4810	MA	2	+	12	.....	Fav.	+	+	+	..	..	..	o	+	+	+	+	..	.....	4, 6
4814	D	Pb	o	24	.....	Fav.	+	+	+	..	..	..	o	+	+	+	+	..	.....	
4817	D	Pb	o	36	.....	Fav.	+	+	+	..	..	..	o	+	+	+	+	..	.....	4
4818	MA	1	o	9	.....	Fav.	+	+	+	..	..	..	o	+	+	+	+	+	.....	2, 4, 6
4783	MA	2	+	8	.....	Fav.	+	+	+	+	..	..	o	+	+	+	+	+	.....	2, 4, 5
4824	I	Pb	o	24	.....	Fav.	+	+	+	..	..	..	o	+	+	+	+	..	.....	4, 6
4827	MA	3	+	6	.....	Fav.	+	+	+	..	..	..	o	+	+	+	+	+	.....	2
4829	D	Pb	o	6	.....	Fav.	+	..	..	..	..	..	o	+	+	+	+	+	.....	2, 4, 6, 7
4839	MA	2	+	16	.....	Fav.	+	+	+	..	..	..	o	+	+	+	+	+	.....	4, 6
4846	MA	2	+	27	.....	Fav.	+	+	+	+	..	..	o	+	+	..	..	..	.....	2, 3, 5, 8
4852	MA	1	o	14	.....	Fav.	+	+	+	+	..	..	o	+	+	+	+	+	.....	2, 4, 5, 6
4878	MA	1	+	5½	.....	Fav.	+	+	+	+	..	..	o	+	+	+	+	+	.....	6
4887	MA	Pb	o	4	.....	Fav.	+	+	+	..	..	..	o	+	+	+	+	+	.....	2, 4, 6
4894	D	Pb	o	16	.....	Fav.	+	+	+	..	..	..	o	+	+	+	+	+	.....	2, 4, 5, 6
4905	N	Pb	o	65	.....	Fav.	+	+	+	..	+	..	o	+	+	+	+	+	.....	4
4895	MA	3	+	6	.....	Unfav	+	+	+	..	..	..	o	+	+	+	+	+	.....	2, 5, 6
4907	MA	1	o	72	.....	Fav..	+	+	+	..	..	..	o	+	+	+	+	+	.....	2, 4, 5, 6, 7
4916	MA	Pb	-	6½	.....	Fav.	+	+	+	..	..	..	o	+	+	+	+	+	.....	

NEGATIVE CASES (Cont.)

Case	Pulmonary Disease: Pulmonary Condition	Pulmonary Disease: Roentgen Classification	Pulmonary Disease: Tubercle Bacilli	Pulmonary Disease: Duration of Illness in Months	Tuberculous Complications	General Condition	Six Hour Examination Barium Shadows: Il	Ce	HF	TC	DC	R	Spasm	Twenty-Four Hour Examination Barium Shadows: Ce	HF	TC	DC	R	Filling Defect Enema Plate	Abdominal Symptoms
4920	MA	2	+	30	.....	Fav.	+	+	+	..	..	..	o	+	+	+	..	..	.....	4, 6, 8
4921	N	Pb	o	18	.....	Fav.	+	+	+	+	..	..	o	+	+	+	+	+	.....	2, 6, 7
4922	MA	2	o	20	.....	Fav.	+	+	+	+	..	..	o	+	+	+	+	+	.....	
4940	MA	1	o	10	.....	Fav.	+	+	+	..	..	..	o	+	+	..	..	..	.....	2, 4, 6
49428	MA	2	+	19	.....	Fav.	+	+	+	..	..	..	o	+	+	+	+	+	.....	4, 6
4943	MA	2	+	4	.....	Unfav	+	+	+	..	..	..	o	+	+	+	+	+	.....	2, 4
4953	MA	3	+	14	.....	Fav.	+	+	+	..	..	..	o	Sl	Sl	+	o	+	.....	
4978	MA	1	o	120	Addison ?	Unfav.	+	+	+	..	..	..	o	+	+	+	..	..	.....	2, 4, 6
4998	MA	2	+	4	.....	Fav.	Sl	+	+	+	..	..	o	+	+	o	o	+	.....	2, 3, 4, 5, 6
5007	MA	3	+	72	.....	Fav.	+	+	+	+	..	..	o	Sl	Sl	+	+	..	.....	4, 7
5024	I	Pb	o	72	.....	Fav.	+	+	+	+	..	..	o	+	+	+	o	o	.....	
5042	MA	1	o	96	.....	Fav.	+	+	+	..	..	..	o	+	+	+	..	..	.....	2, 4, 6, 7
5080	I	1	+	12	.....	Unfav.	+	+	+	..	..	..	o	o	+	+	+	..	.....	
7505	D	Pb	NS	48	.....	Fav.	Sl	+	+	..	..	..	o	Sl	+	+	o	o	.....	3, 6
7681	MA	2	+	11	.....	Fav.	+	+	+	..	..	..	o	+	+	+	+	+	.....	
7770	N	?	o	1	.....	Fav.	Sl	+	+	Sl	Sl	..	o	Sl	+	Sl	o	+	.....	3
7977	I	2	NS	6	Epidid. ?	Fav.	+	+	+	..	..	..	o	+	+	+	+	+	.....	3
5037	MA	2	o	6	.....	Fav.	+	+	+	+	..	..	o	+	+	+	o	+	.....	2, 4, 5, 7
8526	I	2	o	14	.....	Fav.	+	+	+	..	..	..	o	+	+	+	o	+	.....	8
8551	MA	..	+	22	.....	Fav.	18	Ho	ur	Exa	m.	only		+	+	+	o	+	.....	1
8559	MA	2	+	42	.....	Fav.	+	+	+	+	..	..	o	+	+	+	+	+	o	3
8792	MA	1	+	8	.....	Fav.	+	+	+	..	..	..	o	+	+	+	+	+	o	8
8913	MA	2	+	18	.....	Unfav.	+	+	+	+	+	Sl	o	+	+	o	o	+	.....	
9088	MA	2	+	156	.....	Fav.	+	+	+	+	..	..	o	..	..	..	..	..	.....	2, 5, 6
9207	I	..	o	60	.....	Unfav.	+	+	+	..	..	..	o	+	+	+	+	+	.....	1, 4
9192	MA	3	+	6	.....	Fav.	+	+	+	..	..	..	o	+	+	+	o	Sl	.....	8
9141	I	..	+	96	.....	Fav.	+	+	+	..	..	..	o	+	+	+	Sl	..	.....	8
9106	MA	..	+	120	.....	Fav.	+	+	+	+	..	..	o	+	+	+	+	+	.....	1, 2, 3, 8
9105	MA	2	..	120	Effusion	.....	+	+	+	+	+	..	o	+	+	+	+	+	.....	4, 7
4822	MA	1	+	5½	.....	Fav.	+	+	+	+	..	..	o	Sl	Sl	o	o	+	.....	1, 2, 3
5065	MA	2	+	18	.....	.....	+	+	+	..	..	..	o	+	+	+	+	+	.....	
9227	MA	2	+	84	.....	Fav.	+	+	+	+	..	..	o	+	+	+	+	+	.....	4
9228	MA	2	+	24	.....	Fav.	+	+	+	+	..	..	o	+	+	+	+	+	.....	4, 8
4864	MA	2	+	24	.....	Fav.	+	+	+	+	..	..	o	+	+	+	+	+	.....	4, 6
4943	MA	2	+	16	.....	Unfav.	+	+	..	..	..	..	.....	+	+	+	+	+	.....	3, 4, 5, 6
4895	MA	3	+	10	.....	Fav.	+	+	+	..	..	..	.....	+	+	+	+	+	.....	4
5042	MA	2	o	40	.....	Fav.	+	+	+	..	..	..	.....	+	+	o	o	+	.....	3, 6
8779	MA	3	+	20	.....	Fav.	+	+	..	..	..	..	.....	+	+	+	+	+	.....	4
5110	D	3	o	60	.....	Fav.	+	+	..	..	..	..	.....	+	+	+	+	+	.....	
6089	MA	3	+	100	.....	Fav.	o	+	..	..	+	..	.....	+	+	+	+	+	.....	2, 3, 4, 6
4675	MA	3	+	36	.....	Fav.	+	+	+	+	..	..	.....	+	+	+	+	+	.....	4
4153	MA	2	o	36	.....	Fav.	+	+	+	+	..	..	.....	+	+	+	+	..	.....	3, 4
5065	MA	3	+	20	.....	Fav.	+	+	+	..	..	..	.....	+	+	+	+	..	.....	4
5149	MA	3	+	65	.....	Fav.	+	+	+	..	..	..	.....	+	+	+	+	+	.....	4
5142	MA	Pb	+	22	.....	Unfav.	+	+	+	+	+	..	.....	+	+	o	+	+	.....	3, 4
5130	I	3	o	8	.....	Unfav.	+	+	+	+	+	..	.....	+	o	+	o	+	.....	2, 3, 4, 5
5167	I	3	+	12	.....	Fav.	+	+	+	..	..	..	.....	+	+	o	+	+	.....	3, 7
5116	MA	1	o	100	.....	Fav.	+	+	+	..	..	..	.....	o	+	o	+	+	.....	2, 4, 6
5183	D	Pb	o	120	.....	Fav.	+	+	+	+	..	..	.....	+	+	+	+	+	.....	4
5136	MA	3	+	21	.....	Unfav.	+	+	+	+	..	..	.....	Sl	Sl	o	o	o	.....	2, 4, 8,– 1 for ten years
5134	MA	3	+	76	.....	Unfav.	+	+	+	..	..	..	.....	o	o	+	+	+	.....	4, 6
9675	MA	o	+	24	.....	Fav.	+	+	+	..	..	..	.....	+	+	+	+	+	.....	3, 4, 5, 6, 7
9684	MA	3	+	26	.....	Fav.	+	+	+	..	..	..	.....	+	+	+	o	+	.....	4, 6, 7
9700	MA	2	o	24	.....	Unfav.	+	+	..	..	..	..	.....	+	+	+	o	+	.....	1, 2, 3, 4, 5, 7, 8
5186	I	3	o	8	.....	Fav.	+	+	+	..	..	..	.....	+	o	+	o	o	.....	
5203	I	Pb	+	24	.....	Unfav.	+	+	+	+	..	..	.....	+	+	+	o	+	.....	
9750	MA	3	+	8	.....	Fav.	+	+	+	..	..	..	.....	+	+	+	+	+	.....	4, 5, 7, 8
9135	FA	3	+	12	.....	Unfav.	+	..	..	..	..	..	.....	+	+	+	+	+	.....	
5150	D	Pb	o	14	.....	Fav.	+	+	+	..	..	..	.....	+	+	+	+	o	.....	3, 6
5187	MA	3	+	12	.....	Fav.	+	+	+	..	..	..	.....	+	+	+	+	+	.....	4
5204	MA	1	o	122	General Adenitis	Unfav.	+	+	+	o	+	..	.....	+	o	o	o	o	.....	o
9837	MA	3	+	24	.....	Fav.	+	+	+	..	..	..	.....	+	o	o	o	+	.....	3, 4, 5, 6, 8
4902	MA	2	+	6	.....	Fav.	+	+	..	..	..	..	.....	+	+	+	+	+	.....	6, 1, 2, 3, 4, 7, 8
5125	I	2	+	5	.....	Fav.	+	+	+	..	..	..	.....	+	+	+	+	+	.....	2, 4, 5, 7
5194	MA	3	+	45	.....	Unfav.	+	+	+	+	..	..	.....	+	+	+	+	o	.....	
5216	MA	3	+	120	.....	Fav.	+	+	+	..	..	..	.....	o	o	+	+	+	.....	4
5180	I	3	+	7	.....	Fav.	+	+	+	+	..	..	.....	+	+	+	+	+	.....	3, 4
10131	I	Pb	o	6	.....	Fav.	+	+	+	+	..	..	.....	+	+	+	+	+	.....	4, 7
10173	I	..	..	157	Peritonitis	Fav.	+	..	..	..	..	..	.....	o	+	+	+	+	.....	7
10186	MA	—	+	96	.....	Fav.	+	+	o	+	..	..	.....	+	+	+	+	+	.....	3, 4, 5, 7, 8
10229	MA	1	+	108	.....	Fav.	+	+	+	..	..	..	.....	+	+	+	o	+	.....	3, 6, 7
10414	FA	3	..	60	.....	Fav.	+	+	+	+	..	..	.....	+	+	+	+	+	.....	4, 6, 8
																				2, 4, 6, 7, 8

CASES OPERATED UPON

Case	Six Hour Examination Barium Shadows						Site of X-ray Lesion and Spasm	Twenty-Four Hour Examination Barium Shadows					Filling Defect Enema Plate	Sites Found to Be Tuberculous at Operation
	Il	Ce	HF	TC	DC	R		Ce	HF	TC	DC	R		
6867	o	Sl	+	+	+	..	Ce	No	Exami	nation			.....	Ce to TC, inclusive
7644	+	Sl	..	..	..	..	Ce	o	o	o	o	o	.....	Generalized
10068*	+	..	..	..	..	..	Ce	o	o	o	o	+	.....	Ce, AC
8215	+	o	+	+	+	+	Ce	o	o	o	+	+	.....	Generalized
10091*	+	o	+	+	..	..	Ce*	o	o	o	o	+	.....	Ce, AC
9315	+	+	+	+	+	..	TC ?	o	o	o	o	o	.....	None
9562	+	+	+	+	..	..	Ce ?	o	o	o	o	o	.....	Ce
8245	+	Sl	Sl	Sl	+	..	Ce, TC	o	o	o	o	o	.....	Ce, TC
9382	o	+	+	+	o	+	Ce	o	o	o	o	+	Ce ?	Ce, Ceco-colon
9068	+	+	+	..	..	..	Ce	o	o	o	+	+	Ce	Ce, Ceco-colon
5075	+	+	+	+	+	..	Ce ?	Sl	Sl	o	o	Sl	Ce	Ce, Ceco-colon
7588	+	Sl	Sl	+	+	..	Ce, TC	o	o	o	o	o	Ce, TC	Ce to TC inclusive
8985	+	..	..	..	..	..	Ce	Sl	+	..	..	..	.....	IL, Ce to TC
5045	+	Sl	Sl	..	..	..	Ce, HF	o	o	o	o	o	Ce, HF	Ce, TC
7162	o	Sl	+	+	+	..	Ce	Sl	Sl	Sl	Sl	Sl	.....	Ce
7348	+	..	..	..	..	..	Ce	o	o	o	o	+	.....	Ce to TC inclusive
7366*	+	Sl	..	..	..	..	Ce*	No	Exami	nation			.....	Generalized
7541	+	+	o	+	+	..	HF	o	o	o	o	o	.....	HF
7739	+	?	..	..	..	..	Ce ?	o	o	o	o	+	.....	Ce
7822	+	Sl	..	..	..	..	Ce, HF	o	o	o	+	+	Ce	Generalized
4909	+	Sl	..	..	..	..	Ce, HF	o	o	o	+	+	.....	Il, Ce, AC
8544	12	Hour	Exami	nation			.....	o	o	o	o	+	Ce ?	Generalized
8873	+	+	Sl	Sl	+	..	Ce	o	o	o	o	+	Ce	Ce, Ceco-colon
7093	+	+	+	+	+	..	C, TC	o	o	o	o	o	Ce, TC	Ce, TC
5096*	o	o	o	o	+	+	Ce*	o	o	o	o	o	Ce ?	Generalized
9135	+	+	+	..	..	..	.....	+	+	+	+	o	.....	Ileum.

* In the above cases marked with an asterisk the cecum was assumed to be involved, as it was never visualized during the fourth to the eighth hour examinations, and as complete emptying of the bowel occurred in twenty-four hours.

6. This method should be used in studying all patients with advanced pulmonary tuberculosis and all suffering from any abdominal symptoms, or who have failed to respond to treatment for the pulmonary disease.

7. This study is based on 175 cases, of which 44 were positive, 32 doubtful and 99 negative for tuberculous colitis, and on 28 cases operated upon, of which 27 upheld the diagnosis.

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DISCUSSION

Dr. L. T. LeWald.—I wish to give what confirmation I can to this work from a very careful study of Dr. Brown's original plates. I made two trips to his laboratory, and my attention was called to this in June by Dr. Brown and Mr. Sampson, and I believe that we have here an absolute method of diagnosing tuberculous lesions of the colon. While some other pathological change in the colon might give the same thing roentgenographically, when associated with pulmonary tuberculosis the diagnosis seems warranted. There is no reason why other lesions would not give the same appearance, for example chronic amebic dysentery.

Dr. George E. Pfahler.—I have been very much interested in this study ever since Stierlin's article, which was published in 1911. By pure accident this summer while I was touring through the Adirondacks I dropped in at Trudeau and saw the wonderful work that the men are doing there; everyone should visit them when they have the opportunity. You will always find them courteous and willing to help. By accident I didn't know they had been doing this work. I missed a paper they read at Atlantic City. Mr. Sampson was just reviewing his cases when I got there, and I thought it would be a shame if this organization did not see these plates. I wrote Dr. Brown to see if this paper could be placed on the program and called Dr. Brown on the telephone. He and Mr. Sampson are very kind in presenting this paper.

I am sure we are all indebted to them. We must remember this thing: At Trudeau there are a group of tuberculosis experts that are dealing with a group of tuberculosis cases, and we must not run wild on this evidence. Those of us who receive our patients from practitioners and do not have the association of experts in tuberculosis should remember that the irritability of the colon must be persistent, and emptiness of the colon must be persistent. Do not jump to the conclusion that if you find part of the colon empty even on two days it means tuberculosis. It must be persistent emptiness, and it must persist when you inject the colon by rectum. It must be irritable and persistently emptying itself of the opaque meal and it must empty persistently locally after injection of the colon.

I would like to ask how many of these cases came to operation, and just what the surgeons did—of what the operation for this condition consists. I was interested, as I am sure all are, in the case that was opened up and nothing done, and then went down to Ashville and got well. I know that a number of cases of tuberculous peritonitis are opened and then get well and nobody knows why. It may be the same influence in these cases where nothing is done.

Dr. A. H. Pirie.—The presentation of these cases gave me great satisfaction. I remember when Dr. Archibald had none at all; when he sent the first one to me I didn't know that it would lead to all this work being done. The first case I did, I missed the cecum completely. The second one I also missed; and when I missed the third one I began to suspect. In the fourth case I spent a long time watching for the cecum to fill and when I found that it would not fill up I suggested that this was the diagnostic point. Soon after forming this theory I examined a case of suspected tuberculous cecum in which the cecum filled perfectly and I suggested that it was not a case of tuberculous cecum. At operation it was found that the cecum was not tuberculous.

There is a general principle applicable in such cases, viz., that the non-retention by the cecum of barium depends on its irritability. On the same principle if a man has a sore mouth, he will not keep his food long in his mouth; if he has a sore duodenum, he won't have a permanent cap; if he has a sore cecum, he won't retain food in his cecum, and so on all the way down the alimentary tract. It is quite possible that in some early cases of tuberculous cecum, the cecum is not sufficiently irritable to refuse to allow the barium meal to collect in it.

I would like to ask Dr. Brown if he agrees with that statement. In cases where the cecum fills with barium, is it not a fact that those are early cases of tuberculosis? Has he ever seen in an advanced case the cecum filled with barium? The essential thing in the diagnosis I consider is the fluoroscope, so that one may watch the barium leaving the ileum and collecting beyond the cecum.

Dr. Thomas A. Groover.—Yesterday we attempted to show by an analysis of 1300 cases referred to us for gastroenterological examination that seven per cent had tuberculosis. Dr. Brown has perhaps given us a reason why so many of these cases fall into our hands—that there is in all probability a tuberculous lesion of the bowel associated with the pulmonary lesion. Now we have recognized some disturbance of the colon in a good many of these cases, and have suspected the presence of a tuberculous colitis largely by inference, knowing that the patient had a pulmonary tuberculosis, but have failed to recognize anything specifically diagnostic in the roentgenographic appearance of the cecum and colon. I am sure that hereafter we will pay much greater attention to this, and I feel that Dr. Brown's presentation of this subject is of very great importance, and undoubtedly explains why so many of these tuberculous patients fall into the hands of the gastroenterologists.

Dr. Lawrason Brown.—In answer to Dr. Pfahler I would say that the operation of Dr. Archibald is the best I know for these cases. No one has done so much as he, and he and I have discussed it very frequently. What led me to discuss it with him was the idea that occurred to me that in the use of artificial pneumothorax, all we did was to give the lung rest. In intestinal tuberculosis there was no way to give the intestines rest. I think you can defend this statement successfully; that in so far as you can give any organ functional rest, so you can enable it to recover from tuberculosis. Now as you cannot give the intestines rest, operation seems to be the only treatment for the disease. At first we thought that short-circuiting would

fill the bill. In a few cases it does, but in advanced cases the condition is often most deplorable after operation. I feel to-day that if the condition is extensive, it is wiser not to try short-circuiting but to remove the appendix and close the abdomen. If the condition is localized and you can remove it in toto and the lungs can stand it, I should advise excision.

In regard to Dr. Pirie's question, I think he is right in regard to the enema. We have proved two cases to be tuberculous in which the enema didn't reveal anything abnormal; but in regard to the meal we do not feel that this occurs often. We feel that there is always some filling defect and hence infer some spasm. I have thought in view of the case that went down to Ashville that there might be a superficial ulceration that might lead to hypermotility and spasm, and that some of these cases might heal when the ulceration was superficial. We are not advanced far enough along this line to speak positively, but Dr. Archibald will have a number of contributions to make regarding this subject.

Dr. D. R. Bowen.—I am sure we appreciated this very much. I am going to ask Dr. Pfahler to offer a motion to thank Dr. Brown.

Dr. Geo. E. Pfahler.—I would like to make a motion to have a vote of thanks given to Dr. Brown and to Mr. Sampson for their most kind presentation.

Motion seconded and carried.

TELEROENTGENOGRAPHY OF THE HEAD*

BY P. M. HICKEY, M.D.

DETROIT, MICH.

GRANTED that a radiograph which is presented for interpretation should be technically as perfect as possible, it follows that in order to attempt to realize this ideal result, distortion should be eliminated as far as practicable. In plates of the head, the thickness of the part introduces a factor of distortion, which can be minimized by increasing the plate target distance. In order to keep the time of exposure as low as possible, the plate target distance should not be prolonged beyond practical limits. Desiring to determine the practical plate target distance for the varying exposures of the head, the following experimental plates were made: A piece of wire netting with a ¼ inch mesh was placed ½ inches from the plate. Successive exposures were then made with a target plate distance of 20, 24, 28 and 32 inches. At first glance the negatives presented a somewhat uniform appearance. It was found, however, that at 20 inches the distortion was 10 per cent, at 24 inches 8 per cent, at 28 inches 7 per cent, and at 32 inches, 6½ per cent. From this series of plates we may deduce the conclusion that mastoids should be made at a plate target distance of thirty inches.

In order to determine the approximate distance at which plates of the sella turcica should be made, the wire netting was placed at a distance of 3¼ inches from the plate. Serial exposures were then made with a plate target distance of 16, 24, 32 and 40 inches. It was found on measuring the negatives that the wire mesh at 16 inches showed 23 per cent distortion. Negatives made at 24 inches showed 14 per cent distortion. The negative at 32 inches showed 10 per cent distortion, and the negative made at 40 inches showed 8 per cent distortion. From this series of plates, we may deduce the conclusion that plates of the sella turcica should be made with a plate target distance of at least 36 inches. In order to determine the plate target distance for plates of the entire head, the wire netting was placed at a distance of 6½ inches from the plate and a series of exposures were made at a distance of 20, 28, 36 and 42 inches. The negative with a plate target distance of 20 inches showed 36 per cent distortion. The negative with plate target distance of 28 inches showed 28 per cent distortion. The negative with plate target distance of 36 inches showed 23 per cent distortion. The negative made with target plate distance of 42 inches showed 20 per cent distortion. From this series we may deduce that plates of the head, which are designed to show pathology of both tables should be made with a plate target distance considerably more than 42 inches.

The next experiment was made with a dried skull. Three sets of stereoscopic exposures were made at a plate target distances of 20, 36, and 48 inches. The lantern slide of one of each of these sets shows graphically the distortion which ensues with a 20-inch target plate distance. On the other hand at 48 inches the shadow of the inner table approaches quite closely to the normal size. The 48-inch set when viewed stereoscopically shows the right and left sides of the skull with about equal distinctness, and the cancellous tissue more remote from the plate compares favorably in clearness with the opposite side. Consequently, in a set of stereoscopic plates of the head made at a plate target distance of 48 inches any lesion, traumatic or non-traumatic, of either side would be equally portrayed.

In viewing this set a number of important details become well visualized which need only be mentioned, namely, the differentiation of the right and left clinoidal processes, the spacial relation of the

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ethmoid cells, and the graphic distinctness of the maxillary and sphenoidal sinuses. From these plates we may deduce the conclusion that a plate target distance of 48 inches is essential for the proper radiographic study of the entire skull.

Inasmuch as the distance of the sphenoidal sinuses and ethmoidal cells from the plate is never greater than 3½ inches, it follows that for stereoscopic plates of the sinuses, the plate target distance need not be more than 36 inches. However, with a plate target distance of 48 inches, the stereoscopic effect is enhanced and the ideal result more closely obtained.

In stereoscopic exposures made at a plate target distance of 48 inches, the displacement of the tube between the first and second exposure should be from 4½ to 5 inches.

In applying the technic, which seems advisable from these experiments, two problems present themselves, namely, (1) the length of exposure, and (2) immobilization of the head. The long exposure may be made with a tube having a focal point sufficiently broad to withstand the heat generated during such a long exposure, and by the use of double-coated films sandwiched between two screens, the necessary time may be reduced by the factor of one-sixth. This factor would necessarily vary with the various makes of intensifying screens. It is desirable, however, that the tube manufacturers furnish a tube which would stand the long exposure. Such a tube would necessarily have a broader focus than could be chosen for less difficult parts of the body. In order to obviate the changing of tubes, it is suggested by the writer that the tube stands be arranged with a small revolving turntable so that the radiographer could change his tubes from a fine to a blunt focus with the same ease as the microscopist changes his objectives by means of a nose piece attached to the microscope.

The second difficulty in teleradiography of the head is immobilization during long exposure. As it did not seem practical to lengthen the cone to the distance which would permit of pressure from the cone at a plate target distance of 48 inches, and as immobilization by bandages is not agreeable to the patient, the writer makes use of a sheet of celluloid 11 x 14 inches with its edges reinforced by metal and capable of fixation by means of appropriate set screws. This sheet of celluloid placed between the tube and the patient can be adjusted so as to keep the patient's head firmly pressed against the plate holder. The elasticity of the celluloid enables it to conform slightly to the roundness of the part. With patient's head thus immobilized, the tube and cone can be placed at any desirable distance or angle. If it is desired to make use of a second or auxillary diaphragm, a piece of lead with proportionately sized opening can be placed on the celluloid. This arrangement gives all the advantages of a long cone without disadvantages of additional weight. The celluloid being clean and transparent is not objected to by the patient and, furthermore, allows more accuracy in determining the angles of the head in relation to the plate and the central ray. The lantern slide will perhaps show this construction and its application better than the description.

CONCLUSIONS

1. To prevent distortion in head plates, the plate target distance should be increased to the practical limit.

2. Plates of the mastoid region should be made with plate target distance of at least 30 inches.

3. Plates of the sella turcica should be made with plate target distance of 36 inches.

4. Stereoscopic plates of the head, whether made in the lateral or postero-anterior direction, should be made with the tube plate distance of at least 48 inches.

A SAFETY DEVICE FOR X-RAY TUBES*

BY GEORGE C. JOHNSTON, COLONEL M. C. U. S. A.

PITTSBURGH, PA.

THE advent of the modern transformer of large capacity, together with auto-transformer control, has introduced an element of great danger in the practice of roentgenology. Transformers having actual ratings in excess of 6 kilowatts are in common use. The Coolidge tube permits the employment of power greatly in excess of that formerly employed.

Many exponents of deep therapy advocate the employment of voltages as high as 90,000. Under such circumstances, accidental contact with any portion of the excited tube circuit may be expected to result in the discharge of an enormous rush of electrical energy through the object coming in contact with the lines, provided such object is a conductor. It is, of course, not necessary to come in actual contact with any portion of the circuit. Approaching within four to five inches is quite enough. The greater portion of the circuit in a modern installation is composed of aerial lines more than six feet above the floor, but the conductors leading to the tube and the terminals of the tube itself are invariably exposed, and this is the portion of the circuit which, of necessity, in either treatment or radiographic work, is brought into the closest relation with the body of the patient and the head, arms and trunk of the operator.

A recent fatal electrical accident, due to a discharge from the terminal of a tube through the head of a patient to the tube stand and thence to the ground, resulted in attempts at the construction of a protective device which it was hoped would obviate any such future occurrences. The unfortunate individual in the instance referred to had been examined previously and was familiar with the procedure. The accident resulted from a deliberate disobedience of instructions on his part. Having been placed upon his knees with his elbow upon the table for the purpose of determining the condition of an injured elbow joint, and having been cautioned to remain perfectly still, he suddenly, during a one second exposure, partially arose to his feet bringing his head in contact with the cathode end of the tube, whereupon the discharge occurred from the tube terminal to his forehead and emerged through the ear to the tube stand and thence to the ground. In this particular instance, the grounding of the tube stand, of itself a safety measure, introduced an additional element of danger.

In all safety engineering, the following principles are well recognized:

(*a*) All safety devices are presumed by those who come in contact with them, and by the public generally, to give 100 per cent protection.

(*b*) They are presumed to be at all times in perfect working order.

(*c*) Due to the presence of the safety device, additional liberties are presumed to be safe. These traits of human nature must be admitted and taken thoroughly into account in the consideration of any form of safety apparatus.

In the design of the apparatus under discussion, the procedure was first to design and construct a device which, when attached to a tube stand, would render it impossible to come in contact with any electrified portion of the apparatus, the tube, or its conducting wires. A shield necessary to prevent mechanically such contact must, of necessity, be metallic and grounded to the tube stand. With such a device attached, there was no possibility of an electrical discharge occurring from any portion of the tube to any person in its vicinity. Such a device would give absolute protection; but it would be

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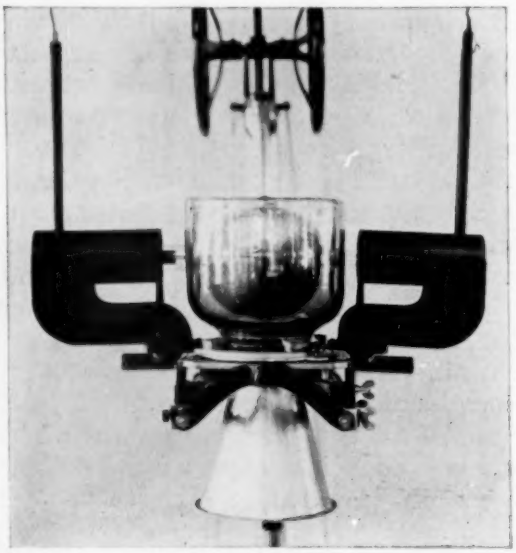
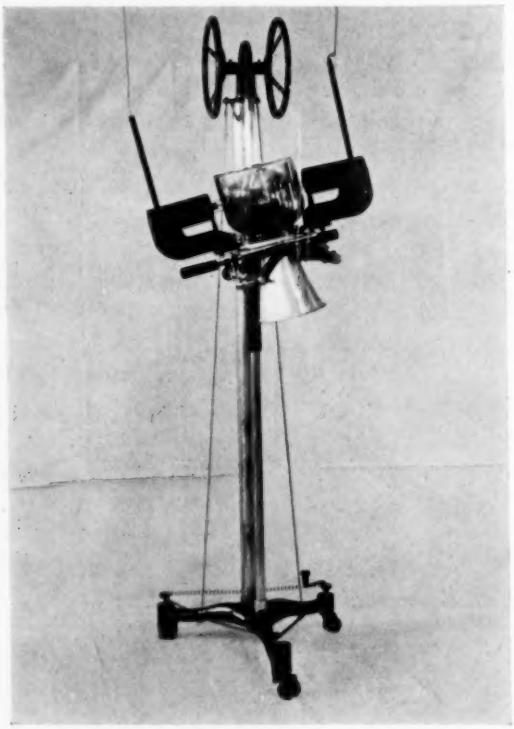
so large, cumbersome and heavy that it would interfere with the proper functioning of the tube stand. If it were reduced in size, so that it would not interfere with the functions of the stand, it would then be necessary to insulate it completely from all high tension portions of the apparatus. Immediately there arose the difficulty of





FIGS. 1 AND 2. ILLUSTRATING SAFETY DEVICE FOR *X*-RAY TUBES.

securing insulating material which would stand the great difference in potential between the tube and its metal shield. Bakelized fiber of sufficient thickness was found to be capable of withstanding the stresses involved. Moreover, a failure of the dielectric would result in inability to operate the tube at high voltages, but the 100 per cent safety factor would remain unchanged. This is the important feature of the invention. The device, if in place, is operative. Breakdown does not diminish the safety. Several modifications in design were necessary before it was possible to produce what is here shown; namely, a device capable of giving absolute protection and capable of operating successfully up to voltages higher than those which can be obtained from any of the modern types of transformers. The device consists of tubes of bakelized fiber closed at one end, into which are introduced the extremities of the Coolidge tube. These tubes are covered by, and supported by means of, sheet metal members which attach to the tube stand. The ordinary tube clamps are dispensed with. The cathode tube is provided with a screw socket having a plunger actuated central electrode. The 12 volt current necessary for the heating of the filament is led into this socket. The Coolidge tube having been screwed in may be given a complete revolution after electrical contact is made. The socket itself is spring supported. Hence, any inequality or variation in the construction of the cathode end of the tube is taken care of. The anode end of the tube slips into a similar bakelized fiber metal supported tube containing in its inner end a three-fingered spring support which grasps the end of the tube, and to which is conducted the positive lead from the transformer. Both the cathode pair and the positive lead are brought into the

large fiber tubes through a thick walled small fiber tube some 15 inches in length. The joint between the smaller and larger tubes is secured by means of a deep thread and insulating compound. Thus all portions of the tube and a liberal distance along the leading-in wires is effectively protected and accidental contact with electrified portions is impossible. The device adds but little to the weight of a tube-stand, and does not interfere in any way with the manipulation, or operation of tube or stand. It, moreover, interposes an efficient and much needed shield when the ordinary type of tube is used in the slotted lead glass bowl. Many unfortunate cases of dermatitis have occurred from stray radiations leaking out through these slots at either end of the tube bowl.

The device for the shielding of the radiator type of Coolidge tube is under construction and presents but few difficulties, inasmuch as these tubes are designed to be used with voltages not in excess of 60,000. The principles employed are the same.

The United States Government has made application for a patent upon this device and it will be employed upon all *x*-ray apparatus in the military service.

DISCUSSION

Dr. Byron C. Darling.—I would like to ask Dr. Johnston what he thinks of a breaker in the main circuit as a safety device.

Dr. George C. Johnston.—There was a circuit breaker on this machine and it is a G. E. breaker, 500 volts, the quickest tripping thing I ever saw. It was set to trip on a small load, but it did not go out. The whole thing is this: there must be no time factor in a safety device. We have moving parts in a circuit breaker and it takes *time* to get them moving. But it does not take any time for an electric current to go through a man and kill him before the breaker would throw out.

Mr. H. W. Dachtler.—I am sorry Dr. Johnston did not go one step farther and devise a wire that would not break.

Dr. George C. Johnston.—We have it in the army, a reel wire that you can hang yourself with, and it won't break. That is one of the things we got after just as soon as we started to have *x*-ray apparatus built. The reel wire that is used in the Army is modelled after a hoisting rope, that is a seven strand rope wound around a canter; you can't break it.

Dr. G. E. Pfahler.—Who makes it?

Dr. G. C. Johnston.—I am not going to advertise it; you can ask the manufacturers.

Dr. H. W. Dachtler.—We have always worked in our therapy work with overhead reels. Fortunately wires break at the hook, and with the reel supported overhead the wire cannot drop on the patient, but in this wire cable the fact that it is attached to a hook is a measure of uncertainty, but if it breaks at the hook, the wire cannot drop on the patient; it will always fly up.

Dr. L. T. LeWald.—I would like to ask about the cause of death, whether there was an autopsy, about the pathological changes. I performed an autopsy on a case of electrocution from low tension on a man who stopped the Broadway line, and he had distinct punctate hemorrhages in the brain, and that was the type of lesion—explosive lesions of the nerve cells with hemorrhages into the cells. In this case it would be interesting to know whether there was such pathology present.

Dr. A. H. Pirie.—I would like to ask whether this is the only fatal case which happened and I would like to ask if there are any other cases on record.

Dr. G. C. Johnston.—This is the only fatal accident I have any record of. One man got a severe burn on the leg. One boy walked into a high tension wire, and the muscular contraction made him leap like a frog, but there were no other serious injuries that I was able to get any report on. Those things are not usually reported.

Dr. G. E. Pfahler.—Where can you get this device?

Dr. G. C. Johnston.—They will be on the market probably within a couple of months.

MULTIPLE MYELOMA OF BONES*

BY WM. A. EVANS, M.D.

DETROIT, MICH.

MY excuse for presenting this subject is the complete absence of references to it in the Roentgen Literature and to the indifferent mentioning of the roentgen findings in cases reported from the purely medical aspects.

The paper is based on our observation of three cases during the past two years of a widespread neoplastic involvement of bone structures. The cases at the time of examination were reported as malignant neoplasm, with no attempt made to classify accurately the type of malignancy, other than that it was suggested that the findings were atypical of either sarcoma, carcinoma or infection.

CASE I.—The records are incomplete, owing to a failure to obtain an autopsy. The clinical diagnosis was pelvic tumor of rectal origin. The roentgen examination was confined to the pelvic structures, the plates showing a malignant new growth of bone origin. The pathological report was myeloma of the plasma-cell type.

CASE II.—Male, age thirty-seven, January, 1918. The patient entered the hospital for relief of pain in the back and chest, the condition having been progressive for five months. The general physical and the special examinations were negative with the exception that in addition to the cachexia, there was swelling over the anterior aspect of the left shoulder, the mass being immovable and nonsensitive, and showing no heat or redness. There was also a small mass of the same character at the inner third of the left clavicle.

FIG. 1. PLATE 1, CASE II.

Note extensive destruction of the upper end of humerus, with involvement of clavicle, scapula and ribs.

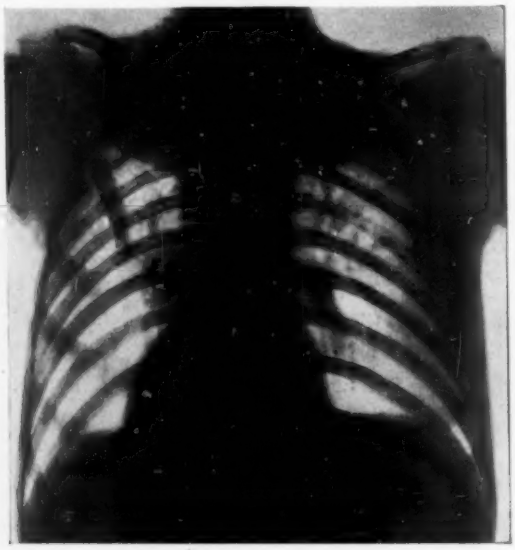


FIG. 2. PLATE 2, CASE II.

Same demonstration of bone lesions as on plate I. Note absence of lung involvement and absence of lime disturbance.

CASE III.—Male, age forty-six years; examination January, 1919. Patient was

* Read before the Twentieth Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Saratoga Springs, N. Y., September 3-6, 1919.

referred for examination of the gastro-intestinal tract with the tentative diagnosis of malignancy, this being based on the history of a 40-pound loss in weight. The only positive findings at this time were in connection with the teeth, where there were extensive apical abscesses, and an increase in the width of the aortic shadow which we suggested was due to lues. This case entered the hospital four months later. In the meantime there had developed severe pains in the back and chest, and the emaciation had progressed rapidly, the total loss of weight at this time being 70 pounds. The general examination was negative. The special examinations revealed a positive Wassermann. The roentgen examination demonstrated a widespread bone lesion which was interpreted as carcinomatosis.

A complete autopsy of both cases (II and III) showed that the lesions were confined to the osseous system, there being numerous tumors of varying sizes. Their consistency was usually soft. On section the new growth was seen to replace the marrow, and in many places the growth had broken through the cortex and appeared externally as nodules. The flat bones, like the sternum and ribs were flexible, containing very little bond. In the case of the sternum, there was almost complete absence of calcium, so that the structure could be cut easily with the ordinary shears. In case II, there was a pathological fracture both at the upper end of the humerus and at the lower third of the femur. The pathological diagnosis in both cases (II and III) was multiple myeloma of the bones with no involvement of the thoracic or abdominal organs.

MacCallum in his textbook gives the most satisfactory definition of the condition: A myeloma is a growth springing up in the bone-marrow and evidently occurring as a systemic affection of the marrow cells since it appears simul-

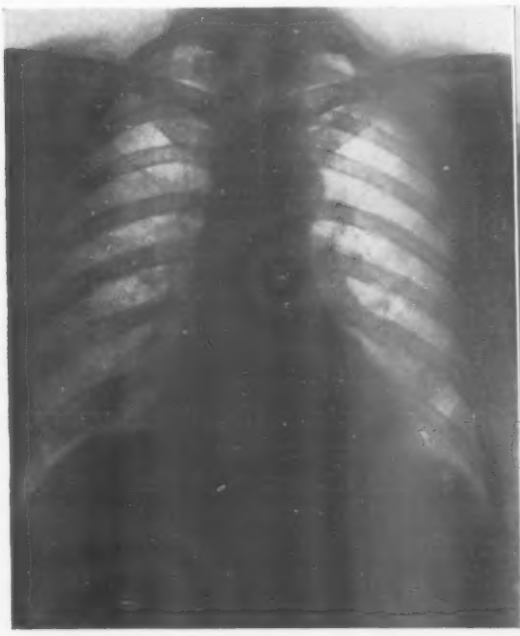


FIG. 3. PLATE 1, CASE III.

Plate made at the time of the first examination. A negative report was made, but a careful scrutiny reveals early lesions.

FIG. 2. PLATE 2, CASE III.

Note extensive involvement of the ribs and clavicles. Also note the absence of pulmonary involvement.

taneously in many bones and nowhere else. In Ewing's "Neoplastic Diseases," McIntyre is given credit for first describing the disease, this being done in 1850 under the term of "Mollities Ossium," and Rusticky (1873) for recognising it as a specific affection of the bone marrow, he classifying it as a "Myeloma."

The etiological factor in the condition has not been determined. One author mentioned trauma as a basis for the condition, but he presents nothing to support the view. Others maintain that the condition is a late or indirect sequel of an infectious process, one case having followed typhoid. Several cases have indicated a dependence on nutritional disorders of bone disease which in other subjects lead to osteitis or osteomalacia. The disease occurs most frequently in middle age, and the proportion between males and females is about three to one.

FIG. 5. PLATE 3, CASE III.

Note extensive involvement of the spinal segments, sacrum and ilium.

The symptomatology of the cases reported in literature coincide accurately with the records of the cases which came under our observation. There are pains in the chest, back, groin and thigh, with increasing weakness and progressive loss of weight. The course of the disease usually extends over a period of from six months to two years, the symptoms being uninfluenced by treatment, and always having a fatal termination.

The literature deals largely with the histogenesis and the disturbance in calcium equilibrium and the presence in the urine of the Bence-Jones protein. Uncertainty and a lack of unanimity is evident in regard to the true classification. The majority of the observers are agreed that the neoplastic cells are derived from the blood-forming cells of the bone-marrow and are related to the primary diseases of the lymphatic and hemapoietic apparatus.

Ewing in the volume mentioned above gives an excellent classification which I believe is the one generally accepted at this time by the majority of pathologists. This classification gives four groups:

1. Plasmocytoma
2. Erythroblastoma
3. Myelocytoma (Adult and embryonal)
4. Lymphocytoma

It is this difference in the type of cell producing the growth which explains the variation in the description of the condition by the several authors. It would also serve to explain why it is held by some that metastasis may occur in tissues of the body other than bones. Our three cases were all of the plasma-cell type and accordingly the growths were limited to the osseous system.

DISCUSSION

DR. L. T. LEWALD.—I have one case that illustrates a great many of the points brought out by Dr. Evans and yet has certain other features that are exceedingly interesting. It is a case of myeloma in which the microscopic diagnosis was made by Dr. Ewing, and yet two other pathologists regarded the tumor and sections of it as round-celled sarcoma. This case is of considerable interest because of the long course it ran, over a period of four years.

The patient finally died three months ago and came to autopsy and the diagnosis was confirmed by sections. Although it ran its course as a one bone myeloma, just prior to death, as the autopsy showed, secondary deposits were found in other bones, namely, in the ribs and clavicles, and metastases were also found in the spleen, liver and heart, which shows a different condition from what Dr. Evans said of metastases, namely that they rarely occur in the solid organs.

Then in regard to its course and etiology: this man had a fracture two years prior to the time a diagnosis of myeloma was made. At that time an *x*-ray was not made, and I do not know whether it was a pathological fracture or a trauma which led up to the starting of the malignant diseases.

I am inclined to think that what he had was a pathological fracture and six months later another fracture. On postmortem examination it was found that union had taken place in the pathological fracture.

Those of you who are familiar with this type of tumor will see from the lantern slide that it is made up of large round cells with large nuclei. There is a difference of opinion among pathologists, but Ewing thought because of this cellular type of tumor it would yield to *x*-ray treatment. Dr. Pfahler also made that suggestion. The patient was given *x*-ray treatment and improvement occurred.

Successive slides of the case before and after treatment and as recently as six months ago show a considerable increase in density of the bone and filling in with lime salts, so that we thought the man was actually going to save his arm. But within six months of that time he died with secondary growths in the organs I have described. It is a type of tumor that is of considerable interest and has perhaps not been studied as much as the sarcomata.

Dr. G. W. Holmes.—The diagnosis in this type of tumor is, I think, a difficult one to make. A point which I have not heard brought out in the discussion is the presence of Bence-Jones bodies in the urine in this disease.

Dr. L. T. LeWald.—Early in this case Bence-Jones bodies were not found, but at the terminal stage they were present.

Dr. Wm. A. Evans.—I believe that the slides shown by Dr. LeWald do not demonstrate the same lesion shown on the plates illustrating my article.

In the slides we have just seen, there was a bony overgrowth, but in cases of true multiple myeloma the lesion is one which is produced by an extension outward of a growth which begins in the medullary portion of the bone, the cortex being destroyed by pressure of the expanding new growth. Dr. LeWald's case was undoubtedly one of sarcoma, while multiple myeloma should not be so classified, it being a distinct entity.

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ADDITIONS TO EDITORIAL BOARD

It gives the JOURNAL much pleasure to announce the addition to its Editorial Board of the names of Professor A. Béclère, of Paris, Sir Robert Knox, of London, and Doctor R. Ledoux-Lebard, of Paris.

There is no need formally to introduce these gentlemen to Americans who habitually peruse the world's literature dealing with the subject of *x*-rays. In the minds of those of us whom the war brought in direct contact with French and British radiologists, these names will rekindle delightful memories.

Thus is created a closer relationship between American roentgenology, through the official organ of our National Society, and representative scientists and teachers of the European schools. This is a step nearer the new internationalism among scholars upon which the JOURNAL has already commented editorially.

The patriotic activities of our new collaborators in contribution to the science of the radiology of war, will go far to stimulate the further scientific researches of peace. PERCY BROWN.

ROBERT WILSON, LIEUTENANT COLONEL C. A. M. C.

After an operation in St. Andrews Military Hospital in Toronto, from which he never rallied, Lieut.-Col. Robert Wilson passed away on Saturday morning, November 1st.

The news of his death came as a great shock to his many friends in Montreal where he had practised for many years. The illness from which he suffered had given him cause for anxiety for a long time, but true to his profession and to his country he gave himself unstintedly to the work of rebuilding and reclaiming for civilian life those whom the shock of war had deprived of the full use of their muscles and limbs; and it was not until the work was about completed that he consented to take time to care for himself. By this time it was too late and the best medical skill in Canada was unable to save him.

Dr. Wilson was a native of Montreal. He graduated from McGill University in medicine and began to practice in Pt. St. Charles. For years he was one of the G. T. R. Surgeons, and filled an important position on the Staff of the Western

Hospital, especially in the Department of Electro-Therapeutics and *x*-ray. He was a pioneer in *x*-ray work in Canada, and for his labors in that branch of the service is well and favorably known. For a number of years he was Professor of Pharmacology and Electro-Therapeutics at Bishop's College, and it was while engaged in this capacity that he did much of the experimenting which served him in such great stead when the war brokeout.

Lieut.-Col. Robert Wilson, C. A. M. C.

He proceeded overseas with the First Canadian Contingent as an *x*-ray specialist with No. 1 General Hospital, and with this Unit at Étaples, he remained for about a year. He was then recalled to London to the Office of the A. D. M. S., and given the task of organizing the new Department of Electro-Therapeutics with headquarters at Granville Special Hospital. The wastage of war was demanding that every effort be made to reclaim the use of muscles and limbs of which the war had deprived the soldiers, and Dr. Wilson, because of his special knowledge, was appointed to look after this. After this branch had been established and others had been trained for this branch he was called home to organize the work among those who were returning. He was appointed one of the Head Consultants of the C. A. M. C. and given full charge of the Department of Electro-Therapy in Canada with headquarters in Toronto. There he established the Military School of Physico-Therapy, where specialists were trained for all the military hospitals. This is the only institution of its kind in Canada.

Besides this special work, Dr. Wilson was a man well known in many other spheres of life. He was a life member of the Argyle Lodge No. 65 F. and A. M., was a Past Master of the Grand Lodge of Quebec, and a member of St. Matthews Presbyterian Church. He was also a member for many years of The American Roentgen Ray Society. He took a prominent part at the last meeting of this Society at Saratoga Springs, New York.

The sympathy of the Society is extended to his widow, Mrs. Helen Wilson. By his death it is deprived of one of its oldest and most experienced members, and Canada loses one of her foremost roentgenologists. A. Howard Pirie.

Eastern Section of the American Roentgen Ray Society

Announcement of First Annual Meeting

The First Annual Meeting of the Eastern Section of the American Roentgen Ray Society will be held at The Traymore, Atlantic City, Friday evening and Saturday, January 30 and 31, 1920. The informal type of program heretofore so successful in the conduct of the Eastern Midwinter Meetings will be followed in the Section with two important exceptions.

Participation in the program will be limited to members of the Society and such others as may be invited to take part. Members are urged when possible to

have their discussions written for presentation to THE AMERICAN JOURNAL OF ROENTGENOLOGY. This is not, however, to be understood as interfering with the informal character of the sessions.

All physicians and students interested in roentgenology are invited to attend.

Communications regarding place on the program should be mailed to the President, Dr. H. W. VanAllen, 19 Maple St., Springfield, Mass.; those regarding other matters —exhibits, lantern slides, etc., to the Secretary.

To secure prompt attention, please address Dr. David R. Bowen, Secretary, 235 So. Fifteenth Street, Philadelphia, Pa.

Reservations of rooms should be made directly with The Traymore.

AMERICAN ASSOCIATION OF ELECTROTHERAPEUTICS AND RADIOLOGY

ANNOUNCEMENT

The Annual Meeting of the American Association of Electrotherapeutics and Radiology was held at Philadelphia, September 16, 17, 18 and 19, 1919. The following officers were elected:

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The next meeting will be held in Atlantic City, N. J., September 14 to 17, 1920, inclusive.

TRANSLATIONS & ABSTRACTS

ANDREW J. GRANT, Diaphragmatic Hernia. (*British Med. Jour.*, September 27, 1919. No. 3065.)

The history of the case is interesting as showing the amount of unnecessary hardship inflicted upon a long-suffering and patient soldier by a failure to recognize the great diagnostic value of *x*-ray examination.

B. M., a rifleman, aged twenty-two, was shot by a sniper while occupying a captured German trench. The bullet entered the left side of the chest behind and immediately below the twelfth rib, 2½ inches from the mid-line and was extracted from under the skin on the following day at a point 2 inches below and 1 inch to the inner side of the left nipple line, a through and through wound. The bullet, as frequently happens, had turned round and was pointing base uppermost.

Several months were passed in a general hospital and convalescent home before he was considered fit to return to his regimental depot, which he did about the middle of July, 1917. He complained at his depot that he suffered much pain after food of any description and that he was frequently sick. His statements were disregarded and he was given "medicine and duty." In spite of his complaints he was sent back to France on July 27th, four months after receiving his wound. Every day while in France he suffered pain, and was totally unable to digest the ordinary army ration. He stuck until he could stand it no longer, and was carried down from the line too weak to go as a sitting case. He returned from France, sent home as a case of gastritis. That label has been his undoing. For seven or eight weeks he received treatment for gastritis, after which he spent thirteen weeks in a convalescent home, but without any improvement. He was then given ten days' leave, but on the second day returned sick. He was sent to a "mother hospital." Here also for weeks he was treated for gastritis. He was ultimately, fifteen months after being wounded, discharged from the service as a case of gastritis. After six weeks he came into the care of the author.

On admission it was noted that his general condition was unsatisfactory. Examination revealed the existence of scars in the left lower chest wall as above noted. The heart was slightly displaced towards the right, and was irregular in rhythm. The base of the left lung was dull to percussion, and the respiratory murmur was absent in the lower half of this lung, while râles were heard in the upper half and the greater part of the right lung. His constant complaint, however, was that of pain immediately or very shortly after food of any description was taken, and a feeling of great distention. From the situation of the through and through wound, my opinion at this stage was that the condition might be one of hour-glass contraction of the stomach following perforation by the bullet. The case was clearly one for examination by the *x*-ray.

The following is the report of the roentgen examination: The patient could only take part of the opaque meal and that with great difficulty. Skiascopic examination showed that three-quarters of the stomach was in the thorax. The portion remaining in the abdomen was connected to that above the diaphragm by a narrow passage. Practically all of the opaque meal could be made to pass back into the chest by having the patient turn on his right side in the prone position. The tone of the stomach was poor and peristalsis was not made out. The upper limit of the stomach was about the level of the third rib in front.

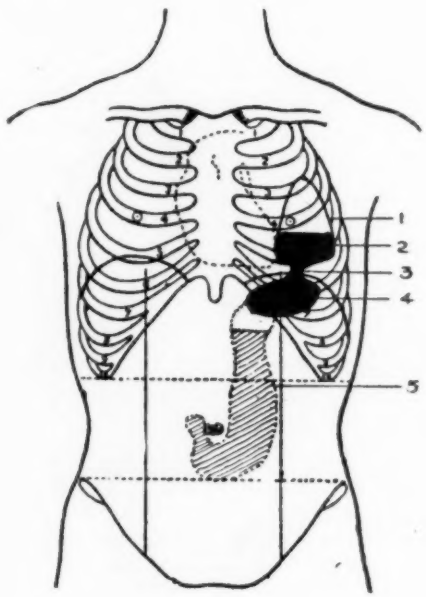
Fig. A is the skiagram taken before the operation. Fig. B another skiagram also taken before operation. Fig. C Skiagram taken some weeks after the operation.

In the diagram the hatched outline shows the normal position of the stomach contrasted with the position of the patient's stomach before operation.

Upon the above findings the patient was operated on. The abdomen was opened, and the transverse colon immediately presented itself. No stomach was visible. It was then seen, by tracing up the bowel from the duodenum, that the entire stomach and great omentum, as indicated by *x*-ray, had disappeared and were on the other side of the diaphragm. With considerable difficulty the stomach was drawn back into the abdomen. The omentum had contracted adhesions to everything it came into contact with and a

portion had to be left in the chest. The opening in the diaphragm was closed with strong interrupted silk sutures. The stomach appeared thickened as though the wall had hypertrophied in the vain effort to pass the food on to the duodenum. His recovery was naturally slow, but was not complicated in any way. The wound healed primarily.

The most interesting point about the case is how the patient ever managed to survive the most extraordinary trials he must have gone through before he was recognized as a serious case.



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